SCIENCE

[Entered at the Post-Office of New York, N.Y., as Second-Class Matter.]

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

SEVENTH YEAR.
VOL. XIII. No. 325.

NEW YORK, APRIL 26, 1889.

SINGLE COPIES, TEN CENTS.
$3.50 PER YEAR, IN ADVANCE.

COMPOSITE PORTRAITS OF WASHINGTON.

THE statement that one of the chief applications of composite photography will be in the direction of producing more reliable portraits of representative men by combining the testimonials of individual artists, will probably be accepted by all who have followed the short but interesting career of this new invention. The suggestion that by combining the individual conceptions of several artists, one would obtain a more reliable portrait than any of the components, was near at hand. The first such application was made by Mr. Francis Galton, who made a composite of six medallion heads of Alexander the Great, and naturally claimed for the composite the combined authority of all the artists; for it is evident, that, while each artist will very likely express the general features of his subject, some peculiar idiosyncrasies of his own are apt to creep in. The composite sifts out all these common traits, and presents them strong and clear, while it reduces each artist's peculiarity to a scarcely perceptible shadow.

In this way we have recently come into possession of a new Shakspeare, for which we have to thank Mr. Walter Rogers Furness. In the case of Shakspeare the diversity amongst the several originals is strikingly evident, and thus a composite was needed to give a characteristic individual, natural face. This suggested to Mr. W. C. Taylor the application of the same process to Washington's portraits. He has grouped the several portraits into three groups, owing to the differences of position of the portraits; and the accuracy of the work is well shown by the fact that the agreement amongst the resulting three composites is very close, while the originals show every shade of individual differences. These portraits were first published in the *Journal of the Franklin Institute*, and are given on a new and enlarged plate in this number. The lower right-hand composite has seemed to many the happiest result, and seems likely to serve as the model for future portraits of Washington.

THE *Paper Makers' Circular* (England) says that the new epoch on which we are entering will surely be known as "the age of pulp." Beyond esparto grass, straw, and wood, few fibrous substances have as yet practically taken the place once occupied exclusively by rags; but, if we should ever exhaust the sources from which we now obtain our supplies, there will assuredly be no lack of substitutes. East Indian ramie, pine-apple fibres, bamboo, bagasse (the refuse matter from sugar-canes), peat, bracken or common fern, flags, rushes, seaweed, tan, and hop-stalks, have all been proved capable of yielding pulp. In Scotland hollyhock-stems have been made into paper; in Ireland the mallow, red clover, hop-vine, and yellow water-iris have been put to the same use; in Demerara good paper has been made from the plantain; in France a patent has been granted for making paper out of leaves, which have been reduced to pulp.

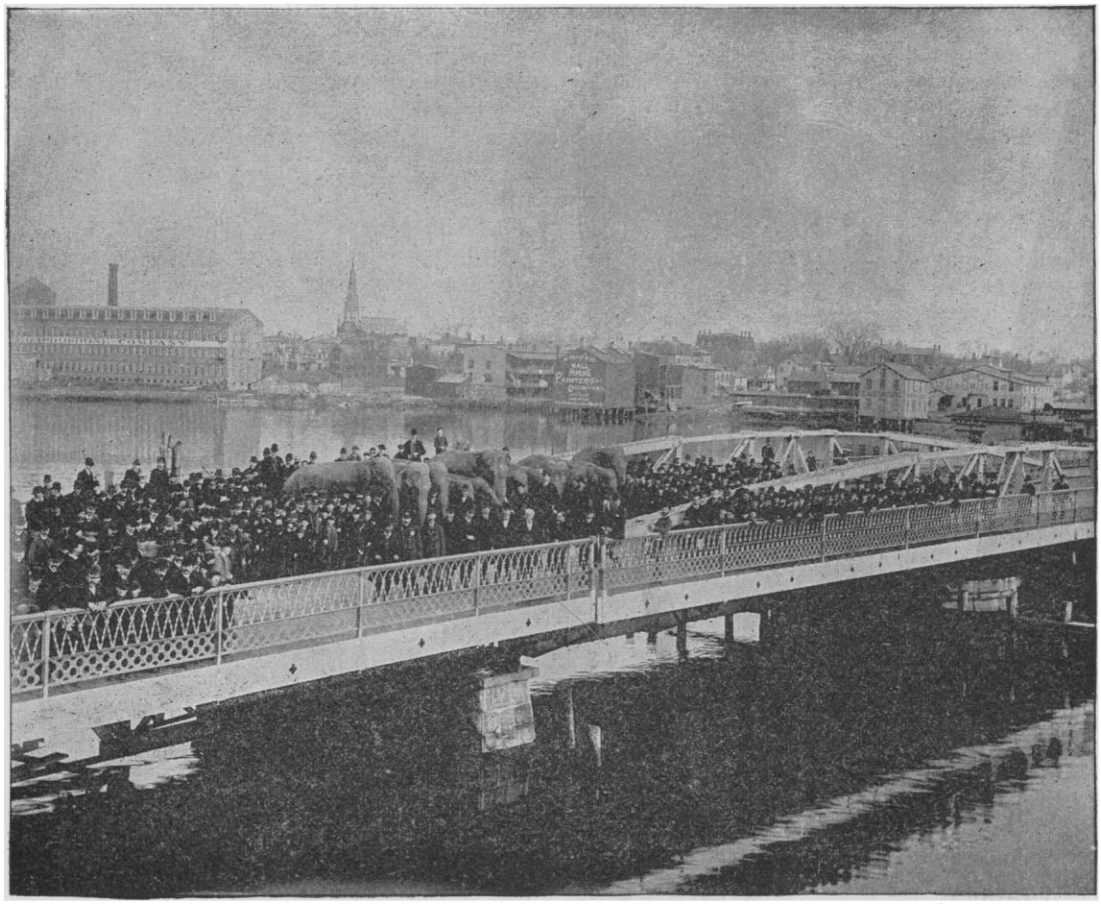
CONGRESS OF ELECTRICIANS AT THE PARIS EXHIBITION.

BY a ministerial decree dated July 16 last, it was decided to hold an international congress of electricians at Paris during the exhibition. All the arrangements are now completed, and the congress will open on Aug. 24, and remain open eight days. The following, relative to this congress, has been issued to those likely to be interested in its work : " The International Congress of Electricians, which met at Paris in 1881, marks an important date in the history of electricity. The consecration of practical unities has had on the development of science and industry an influence the significance of which cannot be exaggerated. The extreme rapidity and facility with which the decisions of the congress were accepted, in the study and in the laboratory, demonstrate their utility. The International Exhibition of 1889 offers a natural occasion of continuing and completing the work of 1881 ; not that the new congress may have to treat of problems of so general and elevated an order, but many questions still remain on which an understanding, or at least an exchange of views, is desirable. In the programme which it has prepared, the organizing committee has not been pretentious enough to indicate them all, and still less to impose limits to the field of activity of the congress : it has simply wished to call attention to those which appeared to it of more general and more immediate interest. We believe we respond to the unanimous feeling of electricians in placing the following questions foremost : practical measure of electrical energy in all its forms ; measure of the current in absolute value with standard of easy reproduction ; electricity meters for continuous and alternating currents ; practical evaluation of the lighting ; definition of the constant quantities of a machine from a commercial point of view ; etc. We hope that the *savants* and manufacturers who have contributed to the progress and application of electricity will readily respond to our appeal, and contribute to give this meeting the importance and authority of that which preceded it."

AN ELECTRIC DRAWBRIDGE.

ONE of the latest applications of the electric motor which has excited much interest, not only from its novelty, but also the excellence of its operation, is that of the turning of drawbridges. This is a matter to which a good deal of attention has been given both by bridge and electrical men ; but it is not until recently that the motor for this purpose has supplanted steam, and the slow, laborious method of the long lever worked by three men.

One installation, the details of which are shown in the accompanying cuts, has recently been made at Bridgeport, Conn., by the New England Electric Supply Company. The drawbridge, which is 180 feet long, 60 feet wide, and weighs 320 tons, was formerly operated by three men ; but this method was found to be open to serious objections, and attended by considerable expense, as it necessitated the constant attendance of the men, and, under the most favorable circumstances, it took six minutes to open and close the draw, which caused a jam on both sides, and seriously interfered with the traffic.



ELECTRIC DRAWBRIDGE AT BRIDGEPORT, CONN.

The problem of applying electricity as a motive power has been successfully worked out to the satisfaction of both the city officials and the bridge-builders. The draw can be opened and closed in two minutes, and the expense is limited to the hiring of one man and the monthly charge of the Electric Light Company, by which a considerable saving is effected. The details of the construction are as follows : —

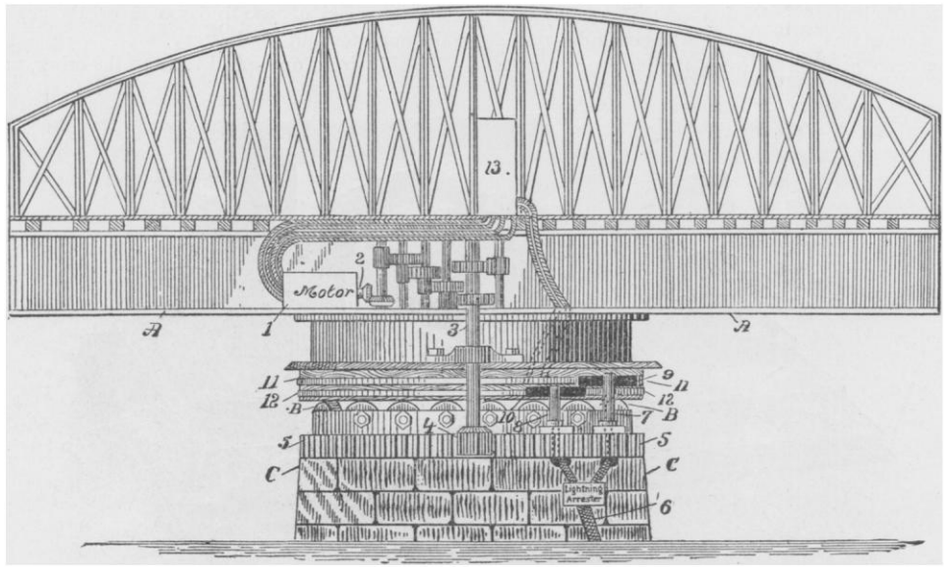
The current is conducted to the motor through two submarine cables, the core being equal to No. 4 B. & S. copper wire, which are protected from lightning by two Thomson-Houston lightning-arresters. The shore ends are connected to the incandescent-lighting current of the Bridgeport Electric Light Company by a double-pole switch, so that the current may be shut off at the pleasure of the draw-tender. The other ends are connected to vertical stationary posts, which are carefully insulated from the

structure, and which carry on their upper ends a pair of brushes which are in contact with two insulated copper bands attached to the circular support of the draw, and moving with it.

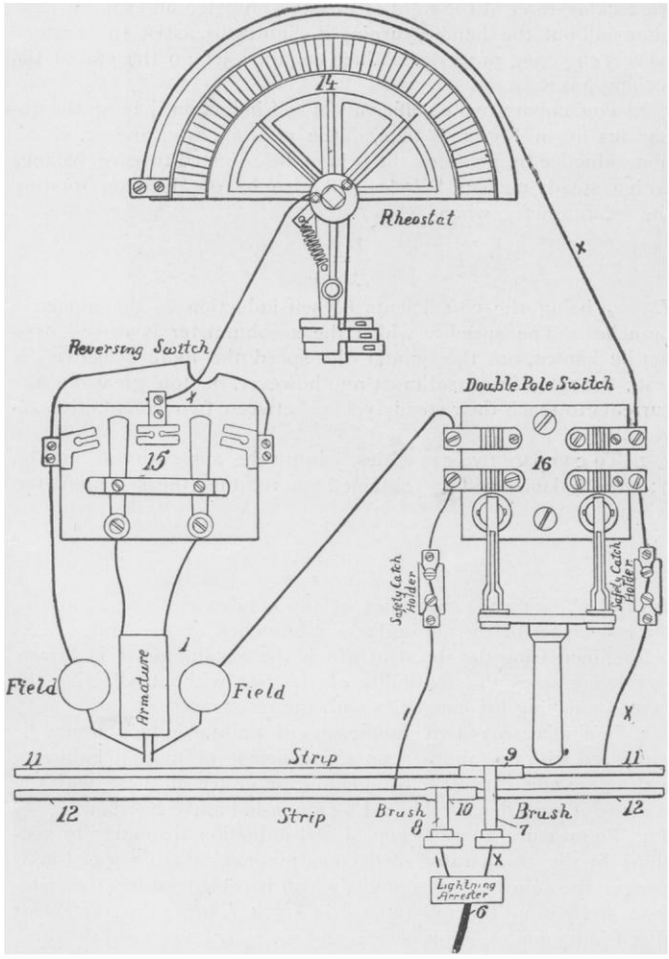
A rheostat is used to regulate the speed of the motor, and a reversing-switch to change the direction of rotation of the armature. The armature, rheostat, and fields are connected in series.

The double switch, fuses, reversing-switch, and rheostat are enclosed in a water-tight box in the framework of the bridge, and are easily accessible from the road-bed. The bridge-tender has every thing under complete control, and can easily regulate the speed and the direction of rotation of the drawbridge.

The motive power is furnished by a 7½-horse-power Thomson-Houston motor, securely fastened to the draw by iron braces. One end of the motor-shaft is a pinion, which drives a train of gears, the last of which turns the shaft formerly operated by the men.



ELECTRIC DRAWBRIDGE ELEVATION.



ELECTRIC DRAWBRIDGE PLAN.

This installation is complete in every detail. Its operation is excellent, and reflects much credit upon the Thomson-Houston apparatus. The New England Electric Supply Company has received much praise from mechanical and electrical engineers for the excellent work they have done here, and has applied for patents on the devices used, and is in communication with several cities contemplating installations of the same nature.

A NEW FORM OF SECOHMMETER.

AT a recent conversazione of the Salters Company in London, a new direct-reading secohmmeter of Professors Ayrton and Perry was shown. This has been designed as a cheaper form than the older instrument, and is intended to be used in comparison of the co-efficients of self and mutual induction. The apparatus, with the cover removed, is shown in the accompanying illustration, taken from the *London Electrician*.

In the earlier forms of the secohmmeter, only a make and break were successively made in the battery-circuit, and the circuit of a shunt to the galvanometer; but, by the use of the double commutator in the new form of secohmmeter, the sensibility of the arrangement is increased fourfold: for, if there be any want of balance in the co-efficients of self or mutual induction that are being compared with one another, or with the capacity of a condenser, the galvanometer receives an impulse in the same direction at every reversal of the battery, which impulse is twice as great, and occurs twice as often, as if the galvanometer-needle received an impulse either only at the making or at the breaking of the battery-circuit, as in the earlier forms of secohmmeter. The fly-wheels make 10 revolutions for every revolution of the handle; and although, by the simple alteration of the gearing previously referred to, the commutators can be driven at will, so as to make either two reversals or eight reversals for every revolution of the handle, the ratio of the speed of the fly-wheel to the speed of the driving-handle always remains the same, so that the fly-wheel action remains constant. The driving-handle can be conveniently turned by hand at speeds varying from about 60 to 200 revolutions per minute, producing with one arrangement of the gearing 120 to 400 commutations per minute; so that both the battery and the galvanometer circuits

can be conveniently commutated from about 120 to 1,600 times per minute, the lower speeds being used for circuits having a large time-constant, and the higher for circuits with a smaller time-constant. The exact range of commutation, however, is made different in the various secohmmeters intended for different purposes.

When the instrument is intended to be employed for absolute measurements of the co-efficient of induction or the capacity of a condenser in terms of a resistance and a time, a speed-indicator is attached to the spindle seen projecting from the commutator in

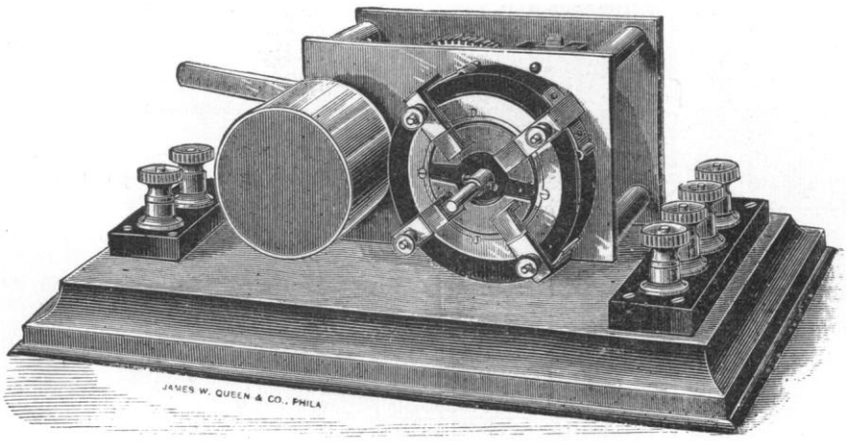


FIG. 1.—AYRTON AND PERRY SECOHMMETER.

the figure. But for comparison of the co-efficients of self or mutual induction with one another, or with the capacity of a condenser, no speed-indicator is necessary.

Another use to which the secohmmeter can be put is the measurement of the resistance of a liquid which is liable to polarize with direct currents, but which, as is well known, will not polarize with rapidly alternating currents.

This instrument consists of two rotatory commutators, each with four stationary brushes. The commutators are on the same

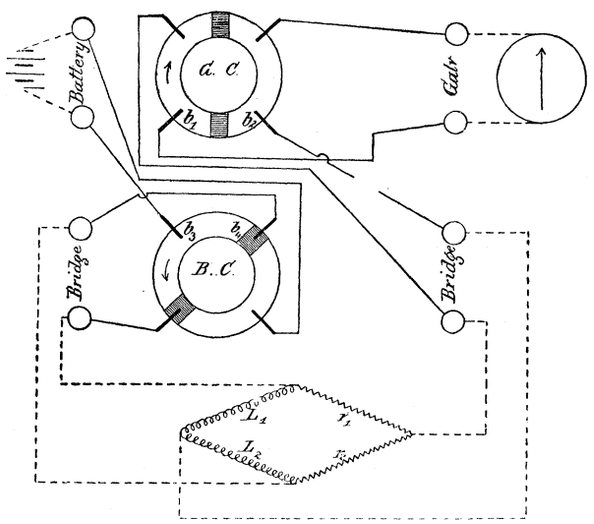


FIG. 2.—COMPARING TWO CO-EFFICIENTS OF SELF-INDUCTION.

spindle, one at the front, and the other at the back of the secohmmeter, but for convenience they are shown in the accompanying symbolical figures as if they were in the same horizontal plane; in reality, however, the brushes, b_1, b_2, b_3, b_4, are at the top of the instrument. One commutator, GC, is for periodically reversing the galvanometer connections; and the other, BC, for reversing the battery connections. An adjustment is provided for enabling the relative positions of the two commutators to be varied, so that both reversals can be made to occur simultaneously, or one a little before or after the other, or one reversal midway between two successive reversals of the other.

The commutators can be driven at one or other of two speeds relatively to that of the driving-handle. With one arrangement there are rather more than 8 reversals of both the galvanometer and of the battery for one revolution of the handle; and with the other, 24 reversals of each for one revolution of the handle. The secohmmeter can be conveniently driven by hand, so as to obtain a steady speed of 300 to 6,000 reversals per minute of both the galvanometer and the battery.

To shift from one speed ratio to the other, press down the end of the locking-lever at the right of the secohmmeter, and slightly push in or pull out the handle, turning it slightly to assist the toothed wheels engaging properly. When engaged, let go the end of the locking-lever.

1. To compare two co-efficients of self-induction, join up the apparatus as in Fig. 2;[1] then, if the resistances r_1 and r_2, of the non-inductive branches of the bridge, be adjusted to give balance with a steady current, balance will also be obtained on rotating the secohmmeter, when

$$\frac{L_1}{L_2} = \frac{r_1}{r_2},$$

L_1, L_2, being the co-efficients of self-induction of the inductive branches. The speed at which the secohmmeter is driven need not be known, but the greater the speed the more sensitive the test; the rate of reversal must not, however, be too great for the currents to reach their steady values between two consecutive reversals.

2. To compare two capacities, join up the apparatus as in Fig. 3; then balance will be obtained on rotating the secohmmeter, when

$$\frac{F_1}{F_2} = \frac{r_2}{r_1},$$

F_1 and F_2 being the capacities of the condensers, and r_1 and r_2 the resistances of the non-inductive branches of the bridge. As before, increasing the speed at which the secohmmeter is driven, merely increases the sensibility of the test without affecting the ratio connecting the capacities with the resistances.

3. In similar ways two co-efficients of mutual induction may be compared with one another, or a co-efficient of mutual induction with a co-efficient of self-induction, or either of these with the capacity of a condenser shunted by a non-inductive resistance.

4. To measure a co-efficient of self-induction absolutely in secohms by the comparative deflection method, attach a speed-indicator to the commutator spindle, which is prolonged for this purpose, and join up the apparatus as in Fig. 4, L being the co-efficient of self-induction to be measured, and r_1, r_2, r_3, values of the three non-inductive resistances that give balance with a steady current. Rotate the secohmmeter handle at some convenient speed, causing the commutator spindle to make n revolutions per second, and observe the steady deflection, d_1, of the galvanometer. Next stop the

[1] The continuous lines represent the permanent connections in the secohmmeter itself; the dotted lines, connections temporarily made outside the instrument.

secohmmeter, and increase or diminish one of the resistances, r_1, for example, by a small amount ρ, obtaining a steady deflection, d_2, of the galvanometer with the battery previously used; then

$$L = \frac{d_1}{d_2} \cdot \frac{r_3}{r_2} \cdot \frac{\rho}{8n} \text{ secohms approximately.}$$

For this test the relative positions of the two commutators is unimportant. They may be as in Figs. 2 and 3, in which case the

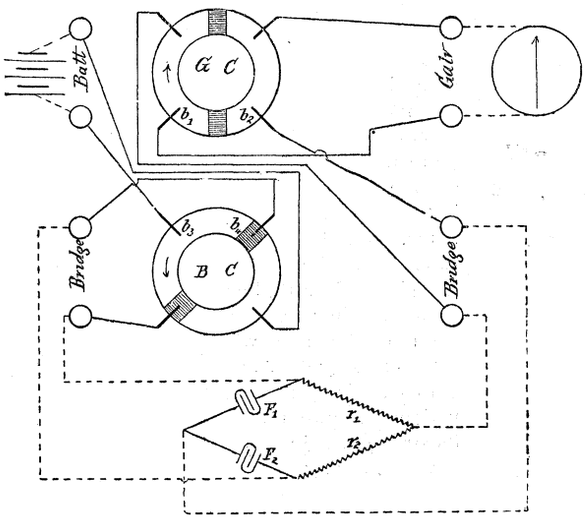


FIG. 3. — COMPARING TWO CAPACITIES.

reversal of the galvanometer occurs midway between two consecutive reversals of the battery; or they may be as in Fig. 4, in which case the reversal of the galvanometer just precedes the reversal of the battery. The greater the value of n, the greater will be the deflection d_1, and the more accurately can it be read; but the speed must not be too great to prevent the currents reaching their steady values between two consecutive reversals of the battery. Whether this condition be fulfilled or not, can be best ascertained

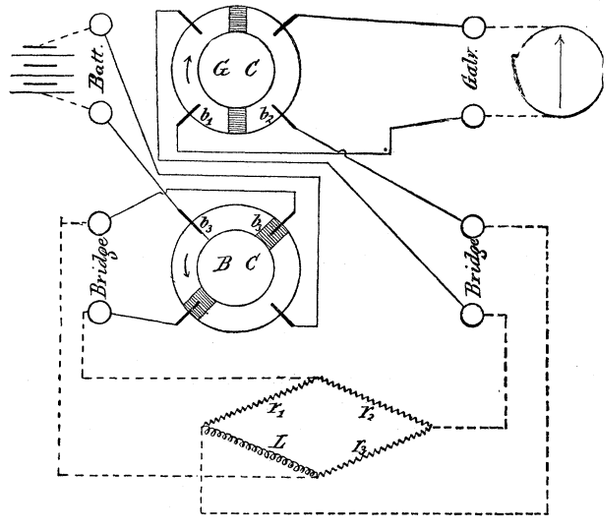


FIG. 4. — CO-EFFICIENT OF SELF-INDUCTION IN SECOHMS.

by seeing whether the same value is obtained for L, for a speed considerably smaller than n.

The sensitive zero method is as follows: Instead of obtaining two deflections, the resistances, r_1, r_2, r_3, are first adjusted to give balance with a steady current, and then one of them, say r_1, is altered by an amount σ ohms, so that there is still no deflection of the galvanometer when the commutator spindle makes, say, n revolutions per second; then

$$L = \frac{r_3}{r_2} \sigma \frac{k}{n} \text{ secohms approximately,}$$

where k is a constant depending on the relative position of the commutators. The value of the constant k is most accurately ascertained once for all, for a given relative position of the commutators, by experimentally determining the value of $\frac{r_3}{r_2}\sigma$, that produces balance for a known co-efficient of self-induction, when the commutator spindle is driven at some known number of revolutions per second.

For this latter test it is necessary that the commutators be so placed relatively to one another that the galvanometer is not reversed exactly midway between two consecutive reversals of the battery; since, with this latter adjustment, no variation in the resistance of any of the arms of the bridge can counterbalance the effect of the self-induction on rotating the secohmmeter handle: in fact, the more nearly the commutators are placed in the midway adjustment, the smaller will be the value of k, and therefore the larger the value of $\frac{r_3}{r_2}\sigma$, to produce balance for given values of L and n.

5. To measure the resistance of a polarizable electrolyte, replace the coil having self-induction in Fig. 4 by the polarizable electrolyte; adjust the commutators so that the galvanometer is reversed just before the battery; and, using the higher speed ratio for the gearing, rotate the secohmmeter at the highest convenient speed. Then, if x be the true resistance of the electrolyte,

$$x = \frac{r_3}{r_2} r_1$$

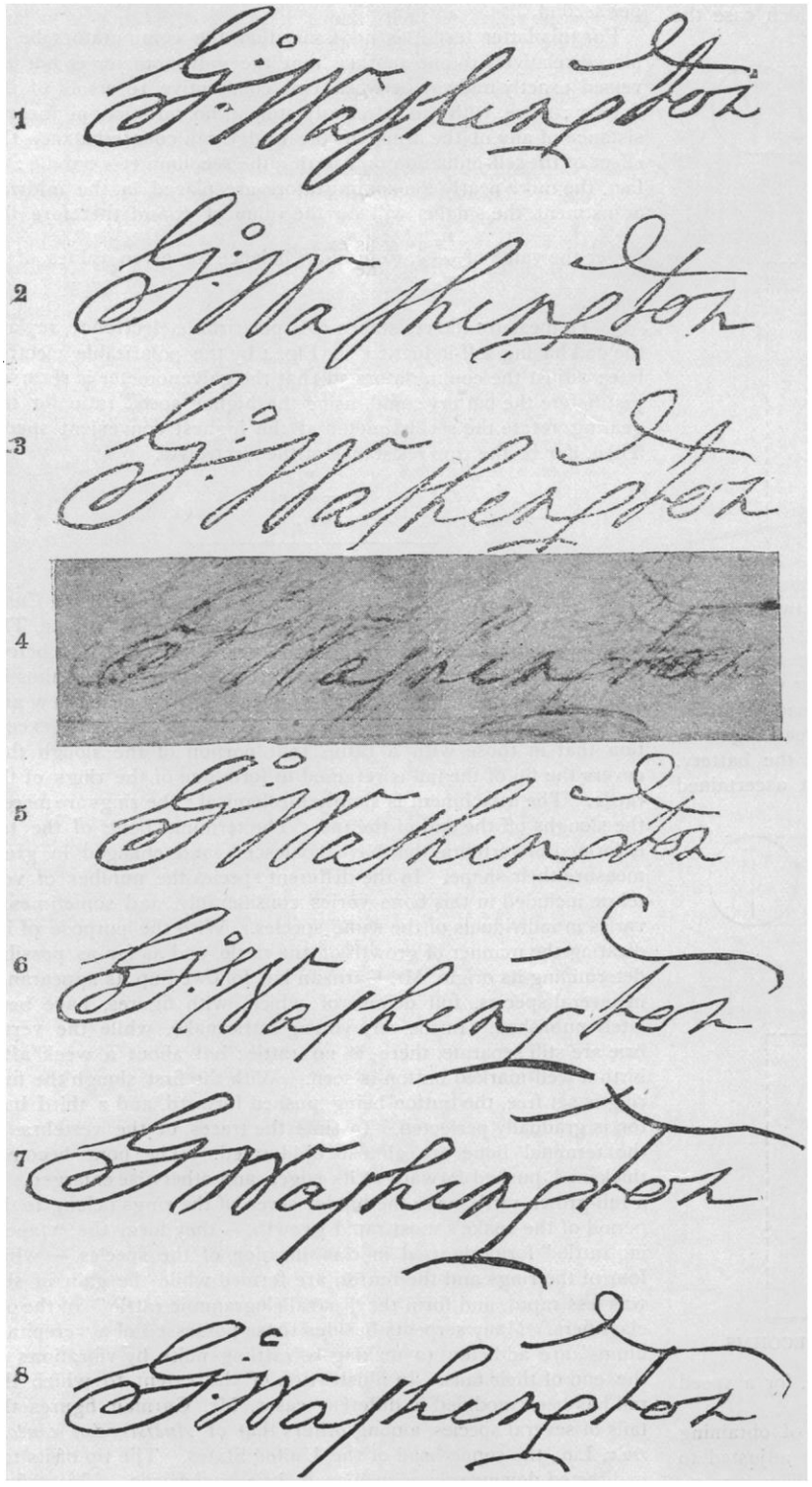
THE RATTLESNAKE'S RATTLE.

MR. S. GARMAN of the Museum of Comparative Zoölogy, Cambridge, Mass., has been investigating the rattle of the rattlesnake. The habit of sloughing is common to all serpents. A short time before the removal of the old skin takes place, the new epiderm makes its appearance beneath the old. The mode of growth of the new and the removal of the old is the same in all snakes, with the exception that in those with a rattle that portion of the slough that covers the tip of the tail is retained to form one of the rings of the rattle. The attachment is simply mechanical: the rings are merely the sloughs off the end of the tail. The terminal bone of the tail is formed of vertebræ that have coalesced, and changed in great measure their shape. In the different species the number of vertebræ included in this bone varies considerably, and sometimes it varies in individuals of the same species. With the purpose of indicating the manner of growth of the rattle, and as far as possible determining its origin, Mr. Garman has followed up its appearance in several species, full details of which, with figures, have been lately published. In the very young rattlesnake, while the vertebræ are still separate, there is no rattle; but about a week after birth a well-marked button is seen. With the first slough the first ring is set free, the button being pushed forward, and a third button is gradually perfected. In time the traces of the vertebræ in the terminal bone are almost obliterated. The bone becomes thickened, pushed forward at its edges, and otherwise enlarged. In a full-grown rattlesnake the hinder seven of the rings belong to the period of the snake's most rapid growth, — they form the "tapering rattle" formerly used in classification of the species, — while four of the rings and the button are formed while the gain in size was less rapid, and form the "parallelogrammic rattle" of the old classifiers. Many serpents besides those possessed of a "crepitaculum" are addicted to making a rattling noise by vibrations of the end of their tails. In illustration of the extent to which the tail has been modified in different cases, Mr. Garman figures the tails of several species, among others that of *Ancistrodon contortrix*, Lin., the copperhead of the United States. The tip of its tail is directed downwards as well as a little backwards. Most often the button has one or two swellings in a degree resembling those on a ring of the rattle. A living specimen of this snake, kept for a year or more, would take to rattling on the floor whenever it was irritated. The sound was made by the terminal inch of the tail, this part being swung from side to side in the segment of a circle, so that the tip might strike downward. The result was a tolerable imitation of the sound made by a small rattlesnake.

WASHINGTON'S SIGNATURE.

DR. PERSIFOR FRAZER published in 1886, in the "Proceedings of the American Philosophical Society," a paper on composite photography as applied to handwriting.

George Washington's signature was one of the first to suggest itself for the purpose, because many persons were familiar with it, and there are numerous well-authenticated documents in existence which bear it; but it has proved to possess other advantages which were not known when it was selected. As in everything else, Washington was deliberate, painstaking, and uniform in his method of writing his signature, and the consequence is that it makes an excellent composite for illustration.



In writing his signature, Washington put pen to the paper five times. First, he wrote the *G W* in one connected line. Second, he raised his hand and made the small *o* between the upper parts of the *G* and *W*, and the two dots which appear in all but signature No. 7. Third, his hand and arm were placed in position to write *ashing*, these six letters occupying a breadth of almost exactly $1\frac{3}{4}$ inches in every signature except the third, when they are extended to $1\frac{13}{16}$ inches. This is about as much of the arc of a circle (of which the centre is the elbow pivoted on the table) as one with a fore-arm of average length can cause to coincide with the tangent, or the straight line across the paper which the lower parts of the letters follow, unless unusual effort be made, and a great deal more movement be given to the fingers. The *g* ends in a curved flourish, of which the convex side is turned upwards below the right centre of the name. The lower loop of the *g* in all the signatures and in the composite was cut off in preparing the plate. Fourth, he wrote the final *ton*. Fifth, he added the very peculiar flourish, above the right centre of the name, with the object of dotting the *i* and crossing the *t* at the same stroke.

In examining the composite, the effect of these various separate movements becomes manifest in its strengthened portions. It is hardly possible that any one, during the period of sixteen years which these signatures represent, or from 1776 to 1792, should have so schooled his hand to write a long name that the first inch or so of the writing should always occupy the same relative position to the body of the signature. It would take at least that much action for the hand and arm and pen to be brought into normal signature-writing condition; and especially is this so when this part of the writing is accompanied by flourishes, as it is in the case we are considering. The *G W*, and the little *o*, and the dots at the top, were the prelude, after which the arm was moved into position to write the main body of the signature, or the *ashing*. Of course, from the manner of making the dots, and the extremely small space they cover, their re-enforcement of each other in the composite was almost impossible, and, in fact, like other subordinate characters, they disappear almost completely. This latter is the part of the name which one would have expected to exhibit the greatest amount of uniformity, as in point of fact it does, with the exception of its terminal *g*, which shows more variation than any of the other letters, because at this point the limit of coincidence between the tangent line of the writing and the curve, of which the right fore-arm was the radius, had been passed, and a freer movement of the fingers was compensating for the increasing divergence. It is likely that Washington sometimes raised the hand between the end of the long *s* and the beginning of *h*, but he does not appear to have moved the elbow. All but the second signature are consistent with this view, and in the first, third, and fifth it is plainly indicated. In the others, as in the flourish above the sixth signature, the pen may not have marked. The fourth separate act of the penman was the formation of the *ton* after a movement of the arm. The breadth of the space occupied by these three letters is from $\frac{5}{8}$ to $\frac{7}{8}$ of an inch, or considerably within the range of coincidence of the curve and straight line before referred to; and owing to this fact there is only a moderate degree of re-enforcement of the letters in the composite, because these letters might fall into the first or last parts of the 2-inch space which was the limit of movement with a fixed elbow. The fifth and last movement was the flourish which dots the *i* and crosses the *t* by one stroke.

METHODS AND MODELS IN GEOGRAPHIC TEACHING.[1]

IT is important in teaching the physical geography of the land that the forms of the earth's surface which are to be considered should be selected and arranged in accordance with some natural and if possible genetic system of classification, and that they should be so clearly illustrated as to impress their essential features vividly on the minds of the students. While continental relief and outline should have brief elementary attention, more deliberate study must be devoted to the small rather than to the large areas of the land, the boundary of each area being determined by the extent of a single kind of structure. A single structural area may be called a geographic "individual;" and all the individuals of one kind are to be idealized in a type. The types of the land-forms are then to be classified, first, according to their structure; and, second, according to the degree of advance that they have made in their destructive development, that is, according to their age. Any individual form may be imagined to pass through a cycle of life, beginning when its surface is presented to the destructive forces of the atmosphere, and ending when these forces have reduced the mass to the level of drainage discharge, that is, to the base-level of erosion. The sequence of forms assumed in this cycle of life is highly characteristic, and justifies the use of such terms as "youth," "adolescence," "maturity," and "old age," to indicate the degree of development that the individual has reached.

Models are employed to impress on the class the essential features of the various types. The models are of a size large enough to be seen by a class of fifty or a hundred students. They are made of paper, colored to indicate certain features, and arranged in nests of two, three, or four, for easy packing. Each nest or group of models represents the successive forms assumed by a single individual as it passes from youth to age. In order to give concrete illustration of their use, the group of forms that may be included under the heading of plains, plateaus, and their derivatives,[2] is described at some length.

A very young plain, like that of the Red River of the North, still retains its embryonic or pre-natal constructional features. It is level; its drainage is poorly developed; and the few streams that have as yet cut their channels in its surface have only incipient valleys, narrow and shallow. The future of such a surface would find it traversed by deeper and wider valleys, and broken by more numerous side-streams, and the originally smooth inter-stream surface becomes broken and diversified. While we cannot wait to see this change in the plains of the Red River, we may elsewhere find it already reached in the more advanced or adolescent stage of other plains, born longer ago, such as the coastal plains of the Carolinas. A still later form is found in the sub-mountainous country of West Virginia, where all resemblance to the initial smooth surface is long ago lost, but where the horizontal structure of the bedded rocks assures us that in its youth this surface was as smooth as the Red River plains are to-day. West Virginia is in its maturity, for here we have the greatest variety and strength of topographic expression. The drainage is most perfectly developed. The streams are most numerous, and carry at this time the greatest share of land-waste to the sea. Central Kentucky is still further advanced. Here the intensity of relief has diminished; for, while the hill-tops have lost some of their initial elevation, the valley-bottoms have not correspondingly gained in depth, having already at or before maturity reached close to base-level, below which they cannot cut. Maturity is passed when topographic expression thus begins to fade. Further advance still more reduces the relief of the surface, until in old age the region is a broad low land, whose monotony is only here and there relieved by low hills, while idle streams wander on the faintest gradients to the sea. The plains about the upper waters of the Missouri in eastern Montana illustrate this stage, — a broad, gently rolling expanse, overlooked by an occasional lava-capped mesa, where erosion has been resisted. When the lava of the cap was poured out from some neighboring vent, it ran down hill to the lowest place that it could find, and there accumulated: the mesas are therefore witnesses to the greater height to which the whole surface once rose. And in the denudation of the original mass to its present ultimate form, it must have passed through all the stages represented by the examples already quoted; it must have had an initial level surface. This was trenched by young and growing valleys, shallow and few in number at first; deeper, wider, and more numerous later on; until in maturity there must have been in this now monotonous country a wilderness of rugged hills and a labyrinth of branching valleys. But as the hills wasted away, the land standing relatively quiet all the while, the relief was lessened, and finally the gently rolling plains of the present time were evolved.

Interruptions in a simple cycle of growth are seen on a closer examination of some of the examples given. The old plains of eastern Montana are no longer lowlands: they are now of considerable elevation above base-level; their rivers are swift, and flow in deep, narrow valleys, even where the rocks are soft and weak, and are interrupted by falls even where the volume of water is large. Manifestly, then, the whole region has lately been uplifted; that is, it has entered a new cycle of life, in which it has only reached early youth, and in which, if it is not interrupted, it will pass through another sequence of forms. The region of the high plateaus of Utah, as described by Dutton, is a wonderful example of the double control of form that appears in individuals not far advanced in a second cycle of growth. The general upland surface had entered maturity while standing at a lower level; it was then raised several thousand feet, and, thus rejuvenated, is now advanced a little way in its second cycle. The great cañons are only in their youth, though so profound: their depth is a sign of precocity, not of great age.

Variations in intensity of development characterize different individuals according as they stand at a great or small elevation above base-level. The coastal plains of the Atlantic slope cannot have deep valleys and strong relief, because their valleys are not allowed any considerable depth of cutting; while the cañons just mentioned give us the climax of intense expression by reason of the great height of the general upland surface over the base-level of the region.

Inasmuch as the association of topographic features at the several stages of development is strongly characteristic, it seems advisable to recognize this association in the manner ordinarily followed; that is, by the use of technical names, of which geography stands in so great need. In the same way, the types of different classes of individuals manifest throughout their life a characteristic succession of forms, such as is well known in those organic forms that undergo metamorphosis. Here again well-defined names applicable to the individuals throughout their whole life may be introduced to great advantage.

The history of a river may also be illustrated by the series of models, showing the first establishment of stream-courses on the lowest lines offered to the rainfall, the later adjustments and changes of streams by their mutual interaction, the accidents to which streams are liable from climatic change and otherwise. The shifting of streams by the mature adjustments of their drainage areas is regarded as a point of much importance in the development of the drainage of a region.

[1] Abstract of a paper read before the Johns Hopkins University Scientific Association, Feb. 13, 1889, by Professor William M. Davis of Harvard College.

[2] See an article on this subject in the Proceedings of the American Association, 1884.

D. C. HEATH & CO. will publish at once "The Laws of Health in Relation to School Life," by Arthur Newsholme, M.D., diplomate in public health, University of London. It is a compend of sanitary science, useful to those who are erecting new school-buildings or modifying those already existing. It is of importance to all who are charged with the responsibility of watching over the mental and physical well-being of pupils of both sexes, in public or private schools or in boarding-schools. It is a book already in use in English training-schools. It has been carefully revised to adapt it to our climate and the needs of American schools. The London *Athenæum* says of it, "It is wholly meritorious and altogether free from any blemishes that we can find. There is nothing to be said of it but that it is excellent." *Nature* says, "Dr. Newsholme has studied his subject thoroughly, and his conclusions are all the more valuable because they have been to a large extent suggested by his experience as a medical officer of health and as a medicinal referee for various schools and training-colleges."

HEALTH MATTERS.

Bacteriology of Snow.

THE following extract from the *British Medical Journal* treats of a subject which is of great interest and decidedly novel: —

"While the bacteriology of ice and hail-stones has been studied with considerable success by Drs. Fränkel, Bischoff, Mitchell Prudden, Pumpley, Hills, Stoben, A. V. Poehl, Bordone-Ufreduzzi, Bujwid, etc., that of snow has been up to the present almost wholly neglected. Even in Russia the subject has been touched only in a cursory way by Professor A. V. Poehl of St. Petersburg, in the *Vratch*. In it he points out (1) that snow always contains viable microbes liquefying gelatine; (2) that, when snow falls, the first portions invariably contain greater numbers of bacteria than the subsequent ones (for example, 8,324 per cubic centimetre of snow-water, against 3,380 several hours later); (3) that, when snow lies on the ground, the superficial layers become richer in microbes (for example, 780 just after the fall, against 962 about three hours later). The fact is of interest from a sanitary point of view, as Dr. Poehl's researches furnish an additional proof that exposure of microbes to low temperatures does not destroy their vitality; at least, in certain species of micro-organisms.

"In many countries, such as Russia or Sweden, snow forms, so to speak, a natural ground or soil during several months of the year, receiving excrementitious matter and every possible kind of refuse and filth. In spring, when the snow melts, it is imbibed by the soil, carrying with it all the polluting matters referred to. Hence an interesting question arises, 'Are such microbes as happen to be present in these matters in any way changed by their contact with snow, or not?' This point can be determined only by further bacterioscopic researches.

"A contribution to the subject has just been published by Dr. F. G. Ianovsky of Kiev, who has examined bacterioscopically, under Professor K. G. Tritshel's guidance, a February snow in its purest state, collected both immediately and from one to three days after its fall. This observer has found: 1. That, even when collected during its fall, snow is invariably found to contain living bacteria in considerable numbers, varying from 34 to 463 per cubic centimetre of snow-water. 2. That their number does not decrease from exposure of snow to low temperatures (—16° C.) for several days. 3. That the following three species of microbes are met with constantly in great numbers: (*a*) a large diplococcus composed of ovoid cocci, endowed with energetic motion, and characterized by its rapidly liquefying jelly (the test-tube culture on the third day, forming greenish colonies along the track of the needle, assumes the shape of a funnel-like sac with a whitish flocculent deposit, while on the fifth the whole medium becomes liquefied, the precipitate sinking to the bottom; on agar, a pale grayish-white streak is formed at the site of inoculation, on potato a fairly thick white film); (*b*) small-sized cocci, often arranged two and two, energetically mobile, and slowly growing on jelly without liquefying the medium, the growth proceeding solely along the track of the needle in the shape of a narrow stripe consisting of non-coalescing minute points of a yellow color, while on the surface the colony is seen as a grayish-white, circular, slightly prominent patch with somewhat fringed edges (on agar, the coccus forms a white streak with sinuous edges; on potato, a gray film with a brownish tint); (*c*) very large cocci, liquefying jelly as late as three weeks after inoculation, and growing along the track of the needle in the form of a sharply defined streak of a beautiful pink color, with a slightly elevated pink circular patch or 'cap' on the surface (on agar the microbe forms a freely spreading white film with a rosy tint; on potato, a thick, tallow-like, pink coat, with sharply defined fringed contours). 4. That the first two species, (*a*) and (*b*), are also met with commonly in the water of the river Dnieper, which flows through the town, while the peculiar pink micrococcus seems to occur only in snow. 5. That, generally speaking, the microbes liquefying jelly in falling or recently fallen snow are met with invariably in far greater numbers than in snow which has been on the ground for some time; this, in fact, very often contains only such bacteria as do not liquefy gelatine. 6. That the bacteria of snow originate partly from aqueous vapors which are transformed into snow; partly and chiefly from the air, that is, they are carried away by the snow-flakes on their passage through the atmosphere."

SCARLET-FEVER. — At the annual meeting of the Rhode Island Medical Society, Charles V. Chapin, M.D., the health-officer of Providence, read a most valuable paper on the method for the prevention of scarlet-fever. In speaking of the origin of the disease, he said that where and when scarlet-fever first appeared is not known, but it has certainly prevailed continuously in Europe since the middle ages, and thence has spread to many other parts of the world. In 1735 it first appeared in this country at Kingston, Mass. It quickly broke out in Boston, a little later in New Hampshire, and gradually within a few years spread over New England, reached New York, and appeared in Philadelphia in 1746. Thence it extended down the coast, and passed over the Alleghanies into Kentucky and Ohio in 1791 and 1793. In 1851 it appeared in California. It was carried to New Zealand and Australia in 1848. During the first part of this century it was imported into Madeira, where it disappeared in 1814, only to re-appear in 1824. In South America it is said to have been prevalent in 1796, but became extinct, and appeared again in Chili in 1829, and in 1831 in Buenos Ayres, whence it spread in 1832 to Brazil. It first appeared in Iceland in 1827, in the Bahamas in 1845, and it was carried to India in a transport-ship in 1870. We know that the aborigines of Africa, North and South America, and Australasia were entirely exempt from this disease until the advent of Europeans. We know also that the early settlements were exempt often for many years; and we know that, in some cases at least, the direct transportation of the disease can be traced. These general facts, taken by themselves and without the corroboration of other testimony, show almost conclusively that scarlet-fever must be due to a material poison introduced from without the body, which poison must be intimately associated with the bodies of the sick. The hypothesis that the disease can be due to any atmospheric or telluric conditions is absolutely untenable. We should cease to talk about mysterious epidemic influences. Specific, by which is meant infectious, diseases can only be caused by specific poisons; and, though obscure meteorological conditions may favor or hinder the development and spread of these poisons, they cannot produce them. If scarlet-fever can be carried in ships half round the globe, or in emigrant trains hundreds of miles across uninhabited continents, and, set free at the journey's end, spread without hinderance, it must be caused by a specific poison. He refers to the work which has been done by Ecklund, Klein, Edington, and others, in the search for the germ of the disease, and comes to the conclusion that it has not as yet been discovered. Extended reference is made to the investigation which was made by *Science* in 1887 and 1888. He summarizes our knowledge of scarlet-fever in saying that it is a contagious disease, the virus of which behaves exactly as if it were a living organism; that it probably does not develop outside the living body, it is probably received through either the alimentary or respiratory mucous membrane; after a brief incubation, the disease is established, and the poison is thrown off from the mucous and cutaneous surfaces as long as inflammation exists or desquamation continues, and is thus disseminated in the air and attached to various articles, is carried from place to place, retaining its vitality for many months. For the prevention of the spread of the disease, he rcommends that the patient be isolated; that a sheet wet with corrosive sublimate be hung before the door of the room which he occupies; that the patient be thoroughly anointed, including his head, morning and night, with the following, advised by Jamieson: carbolic acid, 10 to 30 grains; thymol, 10 grains in an ounce of ointment. Where it becomes necessary, and hospitals exist, patients should be removed to these institutions. At the close of the sickness, every thing should be disinfected. Dr. Chapin concludes his paper by quoting statistics from the report of boards of health, especially those of Massachusetts and Michigan, which demonstrate that sanitary measures have greatly reduced the prevalence of the disease.

DIPHTHERIA. — Dr. J. Lewis Smith, in a paper read before the New York County Medical Association, entitled "The Cause, Mode of Propagation, and Prevention of Diphtheria," says the ex-

treme contagiousness of diphtheria from person to person is well known, and the virus adheres tenaciously to objects on which it happens to alight. The clothing of a patient, even when the disease is of the mildest form, his bedding, the furniture of his room, and the objects which he handles, may for weeks afterward communicate the disease. Dr. Sternberg, in his recent Lomb Prize essay, also mentions the fact that all damp, foul places, such as sewers, cellars, and ill-ventilated spaces under floors, afford conditions favorable for the development and propagation of the diphtheritic virus. The virus, once received, may be propagated in such a place for an indefinite time; and, ascending in the vapors which arise from this culture-bed, it is liable to communicate the disease to any one who inhales it. Thus in New York City prior to 1850, although foul sewers and unsanitary conditions existed, there was no diphtheria; but in the decade following 1850 this disease was introduced. The germ made its way into the sewers under ground; and now, wherever sewer-gas escapes into the domiciles of the city, it carries with it the diphtheritic poison. The amazing vitality and power of propagation of this virus are apparent when we reflect that it has permanently infected the New York sewers, so that children in all parts of the city are constantly falling ill with the disease.

THE BACILLUS OF TUBERCULOSIS. — According to M. Moulé, domestic fowls are frequently the subjects of tuberculosis, the disease often involving the abdominal organs. *Paté de foie gras* is sometimes almost a pure culture of tubercle bacilli. Dr. Squire of the London Epidemiological Society states that the bacillus of tuberculosis may enter the body (1) by inoculation through a cut or scratch; (2) by means of the genito-urinary mucous membrane; (3) by the product of conception, and by direct hereditary transmission; (4) by the mucous membrane of the alimentary canal; (5) by the mucous membrane of the respiratory tract, and by the air-cells of the lungs. The possibility of infection through the ailmentary tract assumes importance from the prevalence of tuberculosis in animals which are used as food, and from the experimental proof of the infectiousness of the milk of tuberculous cows. The present state of knowledge on the subject points very strongly to the necessity for careful inspection of cattle kept for dairy purposes, and for precautions in using the milk, and possibly also the flesh, of diseased animals.

THE CONTAGIOUSNESS OF TUBERCULOSIS. — The New York Board of Health has passed the following resolution: Resolved, that Drs. T. M. Prudden, H. M. Biggs, and H. P. Loomis, the pathologists of this department, be and are hereby requested to formulate a brief and comprehensive statement regarding the contagiousness of tuberculosis in man, stating therein the evidence of the same, and recommending, in the briefest possible manner practicable, the simplest means of protection from its influence.

LEAD-POISONING. — At a meeting of the Practitioners' Society of New York, Dr. Kinnicutt, the president, reported two cases of lead-poisoning occurring from an unusual source. The first patient was admitted to St. Luke's Hospital, suffering from lead colic and "wrist-drop." He had been employed as a florist; and on investigation by Dr. Vaughan, the house-physician, it was found he had been in the habit of biting off the ends of the tinfoil used as wrappers for hand bouquets. The tinfoil used for this purpose contained as much as eighty per cent of lead. There was no history of other sources of lead-poisoning. The second patient was admitted to the hospital, suffering from lead colic, and presenting a typical blue gum-line. He had been in the habit, for several weeks, of drinking beer from bottles which, he said, were cleaned by his employer with lead shot. Dr. R. F. Weir recalled the fact that several cases of lead-poisoning, some years ago, had been traced to the use of a popular brand of chewing-tobacco which was wrapped in tinfoil. Dr. Dana referred to some cases of poisoning which had been traced to the consumption of certain beverages coming in bottles with so-called patent stoppers. He said that he had recently had two Chinese patients in his hospital service, both of whom were suffering from lead-poisoning. He was unable to trace the source of the poisoning.

ELECTRICAL NEWS.

AYRTON AND PERRY'S SECOHMMETER AND SECOHM STANDARD. — In default of a full description, we have to content ourselves with the announcement that Professors Ayrton and Perry will shortly put a standard secohm on the market as an accessory to their secohmmeter. The advantage of such a standard is evident, since it reduces the manipulations with the secohmmeter to a very few simple ones, and dispenses with the use of a speed-counter, or tacheometer, for absolute determinations with the mentioned instrument. This standard secohm will be used much in the same way as any standard resistance would be used in the Wheatstone bridge; in fact, the secohmmeter is nothing more than a very nicely constructed double commutator. Descriptions of the secohmmeter proper appeared in several of the electrical papers some time since. Nothing, however, was said about the use of this instrument. Through James W. Queen & Co., the sole agents for the Ayrton and Perry instruments, we have received a full description explanatory of the mode of using the secohmmeter for determining absolutely, or comparing, the co-efficients of self-induction. This description will be found on another page.

TOPEKA ELECTRIC RAILWAY. — The Topeka Rapid Transit Railway, the equipment of which has just been finished by the Thomson-Houston Electric Company, was put in operation on April 3. This road is said to be the longest in the world (14 miles, 20 miles of track). The trial trip was made on Wednesday, April 3, with four cars filled with invited guests, including the managers and chief officials of the Topeka City Street Railway and the East and West Side Circle Railways, and was satisfactory. The electrical apparatus consists of six 30-horse-power Thomson-Houston generators. The residents of Topeka are enthusiastic, and it is predicted that ere long electricity will be in general use on all the street-railways in the city.

EARTHING LIGHTNING-CONDUCTORS BY MEANS OF GAS AND WATER PIPES. — In the *Elektrotechnische Zeitschrift* (vol. xx. p. 473), A. Voller has an article on the above subject, an abstract of which appears in the *Journal of the Institution of Electrical Engineers*, No. 77. It is generally assumed that the path of the discharge follows only the line of least resistance, and no attention has been paid to the fact, on which Mr. Voller insists, that the direction of the discharge is chiefly influenced by the state of electric potential of the buildings in closest proximity to the charged cloud. The better the connection of the metallic masses in buildings is with the earth, the higher will be the potential of the induced electricity, and the greater likelihood is there of a discharge taking place between the cloud and the points in question. Since the general introduction of gas and water pipes into our houses, it is these which offer the least resistance between the roofs and earth. Hence, if a charged cloud should pass over such a house, the gas and water pipes must be at a higher potential, and there is much greater probability of the lightning entering the house through them than at any other point: in other words, it is more likely that the discharge will take place through the pipes than through the lightning-conductor; and, if the lightning-rod is not connected to the pipes, the discharge will find its way somehow to the latter, causing destruction in its path. At the request of the Hamburg fire insurance companies, Mr. Voller undertook to inspect cases of lightning-strokes, and to ascertain the point struck, as well as the path followed. A great many interesting cases investigated are duly recorded, but some general results only can be reproduced. It generally happened, that, when the building struck was unprovided with a lightning-conductor, the lightning struck some part of the roof or walls, found its way to the gas and water pipes, and then passed harmlessly to earth. In the few cases where lightning struck a building fitted with a lightning-conductor, the discharge jumped over from the conductor to the pipes. In fifteen cases which were specially investigated in the years 1884 and 1888, after the lightning had done more or less damage at the point where it struck, and in the immediate neighborhood, it was found that in nine cases the discharge made its way to earth through the water-pipes, in two cases through the gas-pipes, in two cases through rain-pipes, in one case probably through the lightning-conductor of

a telephone line on the next house, and in one case through an iron crane. In all cases where the pipes were the conductors, the path of the discharge could be clearly traced up to them, and then ceased. One of the cases of discharge through the gas-pipes occurred in an ordinary dwelling-house provided with a lightning-conductor, from which the discharge had passed over a distance of about two metres to the pipes. Subsequent tests showed that the conductor-earth had a resistance of 138 ohms. In no case was any damage done to the pipes by the discharge occurring through them.

NOTES AND NEWS.

THE following is a complete list of the papers presented and read to the National Academy of Science, at its meeting in April: "On Composite Coronagraphy," by D. P. Todd; "Additional Experimental Proof that the Relative Co-efficient of Expansion between Baily's Metal and Steel is Constant between the Limits Zero and 95° F." (read by title), by W. A. Rogers; "Notice on the Method and Results of a Systematic Study of the Action of Definitely Related Chemical Compounds upon Animals," by Wolcott Gibbs and Hobart Hare; "On Sensations of Color" and "Determinations of Gravity," by C. S. Peirce; "On the Pliocene Vertebrate Fauna of Western North America" and "On the North American *Proboscidia*," by E. D. Cope; "On the Mass of Saturn," by A. Hall, jun.; "On the Nature and Composition of Double Halides" (read by title), "On the Rate of Reduction of Nitro-Compounds," and "On Some Connection between Taste and Chemical Composition," by Ira Remsen; "Recent Researches in Atmospheric Electricity," by T. C. Mendenhall; "Measurement by Light-Waves," by A. A. Michelson; "On the Feasibility of the Establishment of a Light-Wave as the Ultimate Standard of Length," by A. A. Michelson and E. W. Morley; "On the General Laws pertaining to Stellar Variation," by S. C. Chandler; "Review of the Trivial Names in Piazzi's Star Catalogue," by C. H. F. Peters; "On Cretaceous Flora of North America," by. J. S. Newberry; "Terrestrial Magnetism" (read by title), Cleveland Abbe; "Spectrum Photography in the Ultra-Violet," by Romyn Hitchcock; "North American *Pelagidæ*" (read by title) and "Development of Crustacea" (read by title), by W. K. Brooks; "The Plane of Demarcation between the Cambrian and Precambrian Rocks," by C. D. Walcott; "Report of the American Eclipse Expedition to Japan, 1887," by D. P. Todd.

— While it will be a long time before compound locomotives will be in extensive use in the United States, the time is not far distant when, in the opinion of the *Railroad Gazette*, they will receive considerable attention and extended trials on our railroads. The demand for decreased operating expenses is becoming too strong, particularly the demand made for a more economical use of fuel, to permit the discouragement of any promising innovation which indicates the possibility of a reduction of fuel-consumption. The saving which is claimed for the double-expansion locomotives in Europe, fifteen or twenty per cent, is sufficient, when applied to the coal-bills of some of our Western roads, to pay a dividend of one per cent; and it is not likely that such a promised saving, offered with so little radical change as that resulting from the introduction of double-expansion engines, will be allowed to pass without notice. It would be well to remember that there is no inherent evil in the compound locomotive which would render it objectionable in American railroad-service. Any representation that it cannot start heavy trains or propel them up steep grades is wholly without foundation. Some of the most powerful locomotives on the face of the earth are compound engines, working on the heavy grades in the mountains of the Eastern Continent.

— Entrance examinations for the Massachusetts Institute of Technology will be held in Boston on May 30 and 31. A second series, for those unable to be present in May, will be held on Sept. 24 and 25. For the convenience of applicants outside New England, entrance examinations will be held on May 30 and 31 in the following cities: New York, at the Fifth Avenue Hotel; Philadelphia, at the Lafayette Hotel; Montreal, at the Windsor Hotel; Chicago, Board of Education rooms, City Hall; St. Louis, office of the superintendent of public schools; Cincinnati, office of the superintendent of public schools; San Francisco, 211 Drumm Street; Washington, United States Geological Survey; St. Paul, High School Building; Pittsburg, at the rooms of the Engineers' Society of Western Pennsylvania; Kansas City, at the office of the Board of Education. Candidates for admission will be allowed, at their option, to divide their entrance examinations between two successive years. The first divided examination will be held only in June; the second, in either June or September of the following year. To be admitted to the first divided examination, the candidate must be at least sixteen years of age, and must have notified the secretary of the faculty, at least two weeks before the date fixed for the examination, of his intention to apply. This notification must be accompanied by a list of the six subjects in which he will submit himself, and by a certificate from his teacher stating that he is qualified in them.

— The Zoölogical Museum at Leyden, one of the most considerable on the Continent, we learn from *Nature*, has narrowly escaped a terrible disaster. On Monday, the 1st of this month, a fire broke out, and all the resources of the officials and of the town were taxed to extinguish it. Indeed, it was not got under until a considerable portion of the collection of specimens of hollow-horned ruminants had been destroyed. Had the accident, which arose from the defect of a flue, taken place at night instead of in the afternoon, when plenty of assistance was promptly at hand, it is believed that the whole museum would have perished. The authorities of other museums, especially those which contain many spirit preparations, should not neglect this warning.

— We have already mentioned that an international meeting of zoölogists will be held in Paris in August. The president, according to *Nature*, will be M. Milne-Edwards, and some important questions will be submitted for consideration. Among them will be the question of the unification of the language of zoölogy in classification and specific denotation. M. R. Blanchard has prepared an important report on the subject, which will be published shortly in the *Revue Scientifique*, and form the basis for the discussions at the congress.

— The Physiological Congress which is to be held in Basle in September will be attended, says *Nature*, by many French physiologists, if all those who propose to go are able to carry out their intention.

— The Eiffel Tower continues to be the hero, so to speak, of various adventures. According to *Le Génie Civil*, which is its official biographer, a story was circulated not long ago in Paris to the effect that it had begun to lean. The outline of the structure makes it very difficult to see whether it is vertical or not; and the rumor spread rapidly, until it came to be asserted that the tower would soon resemble the Leaning Tower of Pisa, to which it was constantly compared. There was no reason whatever to suppose that any movement had taken place; but the public solicitude became serious enough to make it advisable to have the matter tested, and two engineers were sent with theodolites to make a careful survey. As there are no vertical arrises in the tower, the method of observation employed was to trace the intersection of two vertical planes meeting at right angles in the centre of the tower, and bisecting each face. This was done, and the two theoretical planes were found to divide the faces of the tower with almost perfect symmetry, showing that the shaft was not inclined in any way from the vertical. On three of the sides the curvature was found to be exactly as designed, while the fourth side showed a hollow amounting to about an inch of deviation from the intended line. In another affair the tower is the aggressor, instead of being the victim of outside malice. It seems, says the *American Architect*, which is no friend of this structure, that the structure claims to be a work of art, like a picture or a statue, and to be therefore entitled to the benefit of the statutes for the protection of artistic property. Whatever rights of this kind may attach to it have been assigned to a M. Jaluzot, who has undertaken to defend his acquisition by claiming that all persons who sell photographs, models, pictures, or representations of any kind, of the tower, must pay him a royalty on such sales of twenty per cent on the price. As pictures and

photographs, to say nothing of models, large and small, in gold, brass, bronze, and many other materials, are for sale all over Paris, the royalty would amount to a very substantial sum, and some of the dealers interested have refused to pay; so that the whole question of the right of the structure to the protection accorded to pictures and poems is now before the tribunals, and the result will be awaited with some curiosity.

— The *American Architect* calls attention to an improvement recently introduced into the design of boilers, which promises to effect an important economy in the production of steam. An article in *Le Génie Civil*, by M. Lisbonne, a retired director of naval constructions, describes some experiments made with a boiler furnished with tubes having ribs, or flanges, on the inside, so as to present a larger surface for absorbing the heat of the fire. The projection of the flanges is about one-quarter of the diameter of the tube, and eight of them are spaced at equal distances around the inner surface. The tubes, which are the invention of M. Jean Serve of Gisors, are now drawn by special machinery out of brass, so that they require no soldering, and are strong and easily cleaned. The first experiments with them were made in a steamboat on the Rhone. A boat with copper tubes of the ordinary kind was carefully watched, and it was found that the combustion of one pound of coal would evaporate seven pounds of water, while the temperature of the smoke as it issued from the boiler was 680° F. The tubes were then taken out and replaced with M. Serve's tubes, and the evaporation immediately rose to nine and one-third pounds of water for every pound of coal consumed, and the temperature of the escaping gases fell to 460°. These results would seem to indicate an economy of about one-third in consumption of coal; and some other experiments, in which the quantity of coal consumed was observed, showed an actual saving of twenty-four per cent in coal. At the naval arsenal in Brest some further tests were then made by officers of the government, with the result that with natural draught the economy of coal effected by using the flanged tubes in place of smooth ones was, with a given quantity of water evaporated, fourteen per cent, while with forced draught the economy was eighteen per cent.

— *Garden and Forest* states that thousands of acres have this year been planted with fruit-trees in those districts of southern California where the "land-boomer" recently set all the world mad with speculation. In the San Joaquin valley large numbers of new settlers have lately established themselves in colonies for the purpose of fruit-growing, dividing their land into twenty and forty acre tracts. In San Diego County the acreage devoted to this industry is five times as great as it was a year ago, and in Los Angeles and many other counties it is one-third greater; and, moreover, the old "placer-mining" counties are rapidly transferring their attention to fruit, and it is now the richest crop of Tuolumne, for example, once a conspicuous centre of gold-production.

— The next congress and exhibition of the English Sanitary Institute will be held in Worcester, England, at the end of September.

— The Watson gold medal and a hundred dollars in gold, founded by Dr. James C. Watson, for the most important discoveries in astronomy, have been awarded to Dr. Edward Schonfeld of the University of Bonn, Germany. The medal is given to Dr. Schonfeld for his researches concerning the variable stars, and for his work in cataloguing the stars brighter than the tenth magnitude, from the equator to the southern tropic.

— The regents of the Michigan State University have appointed Professor John Dewey, now professor of philosophy in the Minnesota State University, to the chair of philosophy, made vacant by the death of Professor George S. Morris. Professor Dewey was for several years assistant to Professor Morris. The title of assistant professor of mechanical engineering was conferred upon Lieut. L. D. Miner, who was recently detailed for service here by the secretary of the navy. The resignation of Dr. C. H. Stowell, professor of histology, was presented and accepted, to take effect Oct. 1, as was that of Professor J. W. Langley from the chair of general chemistry and metallurgy, to take effect June 30, and Louisa Reed-Stowell, assistant in microscopical botany, to take effect Oct. 1. It is announced that the widow of the late Professor Elisha Jones has established a fellowship with $10,000, to be named after her lamented husband.

— At the business session of the National Academy of Sciences at Washington, D.C., held on the morning of April 18, a home secretary and council, consisting of six members, were elected. Professor Asaph Hall, who has served six years as home secretary, was re-elected. The members of the council elected were Professor George J. Brush of New Haven, Conn.; Gen. Francis A. Walker; Benjamin Apthorp Gould of Cambridge, Mass.; Professor Ira Remsen of Johns Hopkins University, Baltimore; Gen. Montgomery C. Meigs; and Professor Simon Newcomb. The following new members of the academy were elected: Professor Boss of Dudley Observatory, Albany, N.Y.; Professor Sereno Watson of Harvard; Professor C. S. Hastings, Sheffield Scientific School, Yale University; Professor C. A. White, United States Geological Survey; and Professor Michel of Tufts College, Massachusetts. This makes the list of membership number exactly one hundred, — the first time in the history of the academy that this number, which the unwritten law of the academy fixes as a maximum limit, has been reached.

— At a meeting on April 18, of the trustees of Clark University, the Hon. John D. Washburn, recently appointed minister to Switzerland, resigned the office of secretary of the corporation. The work of the university will begin October next in mathematics, physics, chemistry, and physiology, besides the study of languages. The departments will be gradually organized, and on the highest plane possible. While not declining to confer the degree of A.B., the university will for the present give attention to qualifying for higher degrees. Ten fellowships of four hundred dollars, ten of two hundred dollars, and ten scholarships with free tuition, have been provided for.

— From Denver, Col., Mr. J. Wylie Anderson writes to the *American Field* that on a hunt last fall, in company with F. A. Williams, he secured a very rare specimen of clustered antlers, there being thirty-two well-developed spikes, — eighteen on one horn, and fourteen on the other. Another peculiarity about them was that the four main prongs were present on each horn, and extra spikes developed on the outer surfaces of the horns, and that gave them the enormous spread, which at the widest part was thirty-eight and one-half inches. The deer was a very old one, and the beams were very large. The great spread of antlers was almost as great as those of an elk he killed on his trip. Mr. Williams has his specimen mounted, and it adorns his office walls.

— The establishment of the Blue Hill Observatory, and its equipment with means for obtaining meteorological observations of the best class, made it appear probable that the observatory of Harvard College could do more service to science by assisting in the publication of the results obtained at Blue Hill than by enlarging its own field of meteorological work. Accordingly proposals were made for co-operation between the two institutions, which, through the courtesy of Mr. Rotch, the proprietor of the Blue Hill Observatory, have resulted in the arrangement in accordance with which the "Observations at the Blue Hill Observatory" is published as a part of the "Annals of the Observatory of Harvard College." Successive volumes of the Blue Hill observations will appear in the same manner, and the ultimate consolidation of the two institutions is contemplated.

— After having experienced a period of great prosperity, the silk industry in Greece, says the *Journal de la Chambre de Commerce de Constantinople*, is now in a depressed condition. The production of cocoons, which in 1855 amounted to between 1,200,000 and 1,400,000 kilograms, fell, in the period comprised between 1870 and 1880, to about 500,000 kilograms. Since the year 1884, this quantity has still further decreased; and the production, which is centred in the south of the Peloponnesus, in Messenia and Laconia, did not exceed 200,000 kilograms of cocoons, that is to say, a yield in silk of about 18,000 kilograms, of which about 10,000 kilograms are exported. This diminution must be attributed to the disease of the silkworms and to the low price of cocoons. Almost all the cocoons and silks from Greece are shipped to Marseilles, and Calamata is the principal port for shipment.

SCIENCE:

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

PUBLISHED BY

N. D. C. HODGES,

47 LAFAYETTE PLACE, NEW YORK.

SUBSCRIPTIONS.—United States and Canada.....$3.50 a year.
Great Britain and Europe..... 4.50 a year.
Science Club-rates for the United States and Canada (in one remittance):

1 subscription	1 year.....	$ 3.50
2 "	1 year.....	6.00
3 "	1 year.....	8.00
4 "	1 year.....	10.00

Communications will be welcomed from any quarter. Rejected manuscripts will be returned to the authors only when the requisite amount of postage accompanies the manuscript. Whatever is intended for insertion must be authenticated by the name and address of the writer; not necessarily for publication, but as a guaranty of good faith. We do not hold ourselves responsible for any view or opinions expressed in the communications of our correspondents.

VOL. XIII. NEW YORK, APRIL 26, 1889. No. 325.

CONTENTS:

THE HENRY DRAPER MEMORIAL.

THE third annual report, just published, shows that the researches which constitute the Henry Draper Memorial have consisted for the last three years in the photographic study of the spectra of the stars. While this subject will continue to be the principal one under investigation, Mrs. Draper has decided to extend the field of work undertaken so as to include the study of the other physical properties of the stars by photography. The first research undertaken is now rapidly approaching completion, the plans for the study of the southern stars have been matured, and this study will soon be begun. The detailed study of the spectra of the brighter stars is making progress, and a large piece of photometric work will soon be undertaken with a new telescope.

The Bache telescope, which has an 8-inch photographic doublet as an objective, is used for the catalogue of spectra of bright stars. The photographs cover the entire sky north of —25°, with exposures of about five or ten minutes. About 28,000 spectra of 10,800 stars have been examined, including nearly all stars visible in Cambridge, of the seventh magnitude or brighter. The catalogue is now nearly ready for the printer.

In November, 1888, the photographs required to cover the sky north of the equator for the catalogue of spectra of faint stars were nearly finished. It was expected that in two months the observations would be completed. The telescope, which was the same as that used in the previous research, was, however, wanted for photographing the solar eclipse of Jan. 1, 1889. It was accordingly sent to Willows, Cal., where it was mounted, and the greater portion of the remaining photographs were taken there. It was then sent to Peru. The few remaining photographs, including the repetition of those found on further examination to be unsatisfactory, will be taken in Peru. The sky from —25° to the south pole will be covered for bright stars as well, and the resulting photographs sent to Cambridge and reduced, as in the case of the northern stars. The advantages of discussing all stars from the north to the south pole according to one system are very great, and are here secured for the first time in so extensive an investigation. If no unforeseen difficulty arises, the photographs will all be completed during the next two years.

The 11-inch refractor, with one, two, or four large prisms over its objective, has been employed in the detailed study of the spectra of the brighter stars throughout nearly every clear night, until stopped by the morning twilight: 686 photographs have been taken, most of them with an exposure of two hours. With the present photographic plates, about 570 stars north of —30° are bright enough to be photographed with one prism, 170 of them with two prisms, and 87 of them with four prisms. To obtain the best possible result, some of the photographs must be repeated many times. The difficulty is increased by the invariably hazy appearance of the lines in some spectra, like that of *α Aquilæ*, which was at first attributed to poor definition of the photograph. It is expected that the work will be completed during the next year by original or repeated photographs of 228 stars with one prism, of 64 with two, and of 12 with four. In general, stars as bright as the fourth magnitude can be satisfactorily photographed with one prism, the spectra obtained being about an inch long. Fainter stars, if of a bluish color, give sufficiently distinct images, in some cases good results being obtained with stars of the seventh magnitude. For example, fourteen stars in the Pleiades are well photographed with this apparatus. With four prisms, much longer spectra are obtained, and many more lines are visible. But certain differences in the character of the spectra are better shown with the smaller dispersion. Numerous photographs have been taken of the variable stars *o Ceti* and *β Lyræ*. The changes in the spectrum of the latter star seem to be undoubted; those of *o Ceti*, if any, to be slight. Various peculiarities in the spectra of individual stars have been detected. One photograph of *ζ Ursæ Majoris* shows the K line distinctly double, and others show it single. Many photographs will be required to determine the law of its variation, if this is due to changes in the star itself. Bright lines were detected in the spectrum of *φ Persei*, putting it in a class in which only two or three other stars are known to fall. In the double star *β Cygni* the two components have spectra of different types,—an important consideration in the theories regarding their formation. The brighter component is of the second type; the fainter, of the first.

Ordinary photographic plates are not sensitive to rays of much greater wave-length than the F line, or 486. By staining the plates with various coal-tar products, the range of sensitiveness may be greatly extended. With erythrosine, the spectrum extends to the wave-length 590. The sodium line D is distinctly seen to be double in the photographs of *α Bootis* and *α Aurigæ*. Various experiments were also made with cyanine, but the plates were not sufficiently sensitive to give good results. The entire length of the spectrum with four prisms, including the portion obtained by erythrosine, is about six inches and a half.

A beginning has been made of the measures of the positions of the lines in the spectrum. A scale of fortieths of an inch has been ruled on glass, and the positions of the lines read off with the aid of a magnifying-glass. Twelve of the photographs of *α Canis Majoris* have been studied in this way. The spectrum of this star is traversed by the hydrogen lines, which are strong, and by other lines which are so faint that they are only visible when the dispersion is large and the definition good. The catalogue thus formed contains about 320 lines. The average deviation of the measures of the same line on different plates is about 0.05 of a millionth of a millimetre, or 0.05 centimetres on the scale of Angström's map. If the line occurs in the solar spectrum, these measures will generally identify it. In other cases the exact position

must be determined by a dividing-engine. If a line can be distinctly seen, its wave-length can probably be thus determined with as great accuracy as that of the position of the solar lines on the map of Angström. In the spectrum of *α Bootis* 140 lines are visible between the D and F lines.

The classification of this large number of spectra is a matter of no little difficulty. Slight differences exist in many stars, and certain stars appear to hold an intermediate position, so as to render a rigorous division into classes impossible. On the other hand, many stars appear to have identical spectra. The first step will be to arrange the stars in groups, and then compare the best defined spectra of different groups. A minute discussion and the measurement of wave-lengths will be necessary only in the investigation of a comparatively small number of spectra.

The 28-inch reflecting telescope constructed by Dr. Draper was assigned to the work on faint stellar spectra. During the first six months of the year a careful study was made of this problem, and the difficulties encountered bore evidence of the skill of Dr. Draper in obtaining good results with this telescope. The best method of using this instrument seemed to be a modification of the form first tried by Dr. Draper, — a slit spectroscope from which the slit had been removed. The rays from the mirror were rendered parallel by a concave lens which replaced the objective of the collimator. As this lens had the same focal distance as the objective of the observing telescope, it was not necessary that either should be achromatic. After long trials with this and other forms of apparatus, a spectrum was at length obtained showing good definition. As the results were not better than those described above, and the instrument, from its size, was slow in operation, the experiments have not been carried further.

The Bache telescope described above has proved an extremely convenient instrument for various purposes. Besides the spectroscopic researches already mentioned, several other investigations have been undertaken with it. Owing to its short focal length, it possesses many advantages over photographic telescopes of the usual form. With exposures of an hour and a half, more stars were photographed in the Pleiades than are given in the engraving accompanying the "Annual Report of the Paris Observatory of 1886," although that work was based on photographs taken by MM. Henry with exposures of three hours, and a telescope having an aperture of 13 inches. Nearly twice as many stars were photographed in this region as were visible with the 15-inch telescope of the Harvard College Observatory. The short focus of the telescope also gives it especial advantages for photographing nebulæ. Twelve new nebulæ were thus discovered in a region where but eighteen were known before. Various other investigations, such as a determination of the law of atmospheric absorption, have been undertaken with the aid of this telescope. It has been so persistently used in spectroscopic work that the other researches have been neglected, especially those in which very long exposures were required. Its removal to Peru now cuts it off for some time from such use on the northern stars. Accordingly, Mrs. Draper has procured a similar lens, which is now in the hands of the firm of Alvan Clark & Sons for retouching and mounting. Several important researches will be undertaken with this instrument. Photography is now used in so many departments of astronomy, that a general investigation of the photographic brightness of the stars seems desirable. A plan has been proposed by which a single plate will contain photographs of a number of regions one degree square, but in different portions of the sky. Thus a series of standard faint stars will be photographed, which can all be measured, and reduced to the same scale. One or more photographs of the vicinity of the north pole will be taken on each plate, and thus serve to correct the results obtained on different plates. It is proposed in this way to secure a series of standards of stellar magnitude at intervals of about five degrees. A third lens of similar form, having an aperture of four inches, will be attached to the telescope, with which photographs on a smaller scale, but five degrees square, will be taken simultaneously. These photographs will cover the entire sky, and it is proposed to measure the photographic brightness of all stars of the seventh magnitude, or brighter, which are represented on them. This investigation will have a special value in connection with the photometric measures of the spectra described above. It is hoped also to photograph the entire northern sky by means of the 8-inch telescope, with exposures of an hour. Each plate covers a region nearly ten degrees square, of which the images in the central five degrees square are satisfactorily in focus. One of the regions containing standard stars will appear in the centre of each plate. By such a series of plates the photographic brightness of any stars brighter than the fifteenth magnitude can be determined on a uniform scale. The faintest stars photographed will be nearly a magnitude fainter than the limit proposed by the Astro-photographic Congress, so that all plates included in that work can be reduced to a uniform system. The advantages of such plates for studies of the distribution of the stars and other similar investigations are obvious.

From the above description it appears that the field of work of the Henry Draper Memorial, as now extended, is almost boundless. The problems to be investigated relate to the fundamental laws regulating the formation of the stellar system. Questions of such importance should be discussed on a sufficiently large scale, or the results of the discussion will soon be superseded by a repetition of the work. The liberal provision made for the Henry Draper Memorial permits the investigations to be planned on a scale which is likely to avoid such an undesirable duplication of work.

EXAMINATION AND EDUCATION.[1]

FOR many years I have watched the examinations of young men in our colleges, with reference to the award of prizes and honors, and also with reference to the terms of admission to college and the conditions of bestowing academic degrees. The conclusions to which I have come are these: —

Daily marks, jotted down by the instructor at the close of an exercise, help him to form an accurate notion of the fidelity of his scholars and of their intellectual growth; but it is usually best for him to keep these marks private, and simply for his own guidance, lest by showing the record to his pupils he should accustom them to the notion that work is over when they have learned the lesson, solved the problems, or written the exercises acceptably. He must not teach them to read for marks, — an odious habit.

Examinations held at frequent intervals, say once a month, three or four times a year, or at the end of a certain obvious block of work, especially if preceded by a brief and spirited review, are as serviceable to the scholar as to the teacher. The true condition of a class can thus be ascertained and recorded. The scholar or his advisers can be informed whether or not he excels, is passable, or is deficient. The good students are thus encouraged to better work: the poor students are warned before it is too late to recover their standing.

Yearly examinations accustom the scholar to hold on to the knowledge that he has acquired. If rightly conducted, they remind the pupil that he must carry in his mind the general principles and the fundamental facts of the subject he has studied. A good examiner will put very different questions at an annual examination from those he would set at the end of a month's study. He will endeavor to ascertain whether the subject taught has been mastered by the individuals examined, not whether every detail can be instantly recalled.

Special examinations at marked epochs in an education — such as admission to college, competition for prizes, and the attainment of a degree — encourage young men to put forth their highest and best efforts, to make strong exertions, to overcome great difficulties. As an important part of the business of life is the overcoming of obstacles, so a good school or college should train its pupils to meet and master tasks that are hard. The well-trained youth will not shrink from such difficulties as he must encounter when he becomes a physician, a lawyer, a statesman, a teacher, an engineer, a philanthropist, an editor, a man of business; in short, when he takes an active part in the affairs of life.

In selecting men for high stations, for appointments by the government, or for college fellowships, or for the position of teachers, other tests than those of an examination must be employed. Evidence that the candidate has exact knowledge, and that his knowl-

[1] A contribution by President D. C. Gilman of Johns Hopkins University to he American Supplement to the Nineteenth Century for March.

edge can be readily and clearly communicated, may indeed be indispensable, and this may be ascertained by examination. But to judge of the general ability of a candidate, of his fidelity, his adaptation to a given position, the probability of his growth, his skill as a "re-searcher," his originality of mind, his perseverance, other tests must be employed than those of an examination-paper. Good judgment, based upon a knowledge of human nature, must be called in.

The advantage of allowing teachers to be the examiners of their classes is obvious: they know what has been taught, and how, and they can say what the scholar ought to remember. At the same time, the advantage of calling in examiners who have not taught the class is also obvious. Pupils are thus reminded that they are expected to know a subject, not a certain part of a text-book. For example: they are to know how to read Cicero, and not to present six orations; they are to read German books, not to say that they have read "Marie Stuart;" they are to know their algebra, their physics, their chemistry, botany, and so on. Probably for the best pedagogical discipline, the board of examiners should be made up partly of the actual teachers of a class, partly of competent, sensible outsiders.

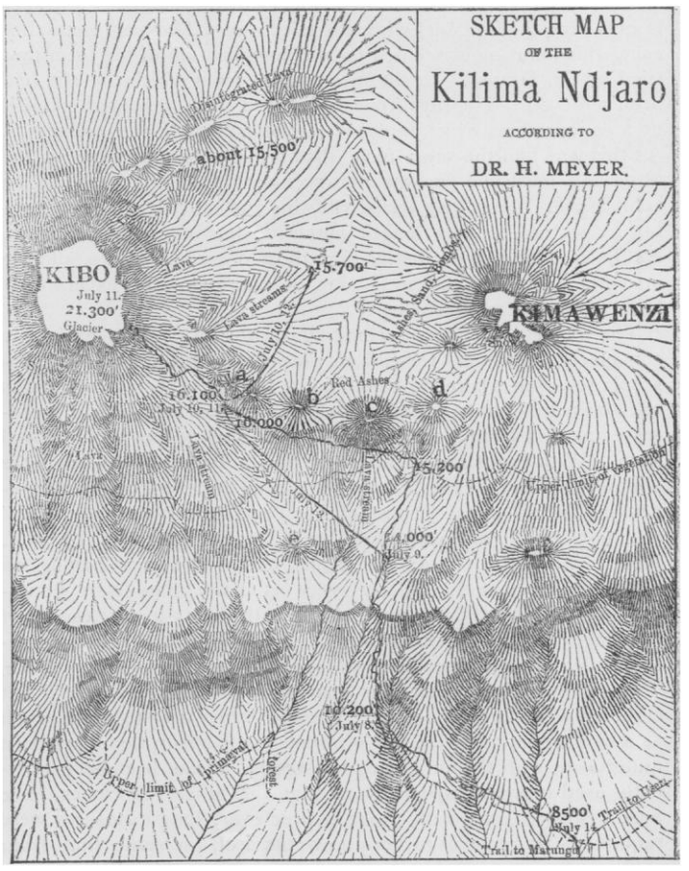
While there is reason to believe that the lower schools of the country suffer from too many or too poor examinations, I doubt whether the colleges rely too much upon their examinations. Some instructors have but vague ideas of the purpose of examinations, and consequently may employ imperfect methods of examining. Examiners are as likely to be at fault as examinations.

It would surely be well for every board of examiners to consider what object they have in view; e.g., is the object to ascertain whether the class as a whole has been well taught? The authorities of a school or college sometimes require this information, and of course an examiner who is not the teacher must be enlisted. Is the object to select those who are most deserving of an honor or prize? If so, sharp test-questions are requisite. Is it to ascertain whether a scholar is capable of going forward with a proposed course of study? If so, a fair, general paper, supplemented if possible by oral questioning, is desirable. Is it to grade a class? Then there should be a paper which every one ought to be able to answer, so as to pass, but with riders, so that the superior scholars may show their attainments, and win the rank which is their due. The highest talents will thus be drawn out, while inferior ability will not be discouraged.

But the subject is quite too complex for a brief discussion, and I fear that I have already filled the space that you offer me.

ASCENT OF THE KILIMA NDJARO.

MR OTTO F. EHLERS made an interesting ascent of the Kilima Ndjaro in company with Dr. Abbott, an American naturalist who had been collecting for upwards of a year in the country round Tavita. The "Proceedings of the Royal Geographical Society" gives the following sketch of this ascent: The travellers left Marangu with a party of thirty men. The first camp was pitched at the foot of a small crater almost due south of the eastern peak, Kimawenzi, at an altitude of about 9,800 feet. On the following day Herr Ehlers made an excursion to Kimawenzi, and reached a height of about 16,400 feet; any further ascent of this remarkable jagged mountain seemed to him impossible. The same day the travellers saw three specimens of a new species of antelope. The two following days were spent in collecting plants and searching for a suitable camping-place, where the majority of native followers might remain, while the travellers proceeded up the mountain. A spot was chosen to the west of their last camping-ground, at an altitude of about 10,500 feet. From here the two travellers started with five men, and provisions for four days, taking a northerly direction up the saddle between Kibo and Kimawenzi. After some hours' marching, they discovered that they had made the same mistake Dr. Meyer had in 1887, and were proceeding in a direct line to the summit of the lower eastern peak. Being at this moment overtaken by a snow-storm, they pitched their camp at an altitude of about 15,500 feet. On the following morning, which broke bright and clear, they set out in a westerly direction over the newly fallen snow, proceeding along the northern edge of the line of lava hills mentioned by Dr. Meyer, whose route lay along their southern side. After much toilsome marching, snow having commenced to fall again, the natives were compelled to return, leaving the two travellers to push on to their last camping-ground (Nov. 17). The morning of the 18th was exceptionally clear, and an early start was made over the hard-frozen snow. At seven o'clock they found themselves at an altitude of 16,200 feet, about the middle of the eastern side of the summit. Instead of attempting to ascend from this side, as Dr. Meyer had done, they proceeded in a north-westerly direction over lava-streams and rocky bowlders to the northern side of Kibo. Unfortunately, at this point Dr. Abbott completely broke down, and Herr Ehlers pushed on alone. Keeping to the east of a mighty lava-stream, he pushed his way over sand, ashes, and rubble, covered with the freshly fallen snow, and after repeated halts, but without suffering at all from the rarity of



the atmosphere, he arrived at 10 o'clock at the ice-wall which completely encircles the actual summit, and the scaling of which at this point was impossible. He consequently proceeded along this wall of ice for some distance, in the hope of finding a point at which it could be surmounted, but after a time was compelled to retrace his steps, owing to a steep fall in the ground. Descending the summit a little, he contrived, by much toilsome climbing, to get round to the north-east side of the summit; and here, from a point of some little elevation, he obtained a comparatively wide view over the summit. He could discover nothing in the form of a crater: the mass of snow and ice lay before him in a succession of gentle undulations. This is somewhat remarkable, in view of Dr. Meyer's account of the crater of the summit. He does not give the exact height attained, as he prefers to wait until the instruments used have been tested, but states that it exceeds 19,600 feet. The descent was made by a somewhat different route, in a direct course to the south-east. At an altitude of 16,400 feet the track of an elephant was observed in the snow, also those of buffaloes and antelopes. Here also he found the last traces of vegetation. The return to Marangu occupied three days.

STANLEY'S DISCOVERIES.

THE accompanying map of the Aruvimi River has been compiled from two sketches, — one published in the *Mouvement Géographique;* the other, in *Nature*, — both being extracts from a map accompanying Stanley's letter. The original will presumably be published in the "Proceedings of the Royal Geographical Society." The names of places appear still somewhat doubtful, being differently given on the two sketches.

Stanley's discoveries form a most important addition to our knowledge of Central Africa. It appears that Mr. Wauters's hypothesis of the connection of the Nepoko and Aruvimi was well founded, as the former is an important tributary of the Aruvimi. It remains an open question whether there is any connection between the Aruvimi and the Mootan Nzige, the southern of the two large lakes. Mr. Wauters presumes that the Lunda (or Lenda), the southern tributary of the Aruvimi, may be the outlet of that lake, but we have to await more detailed reports before we will be able to form an opinion on this point. The tributaries which Mr. Stanley describes in his map have probably been drawn according to reports received from natives.

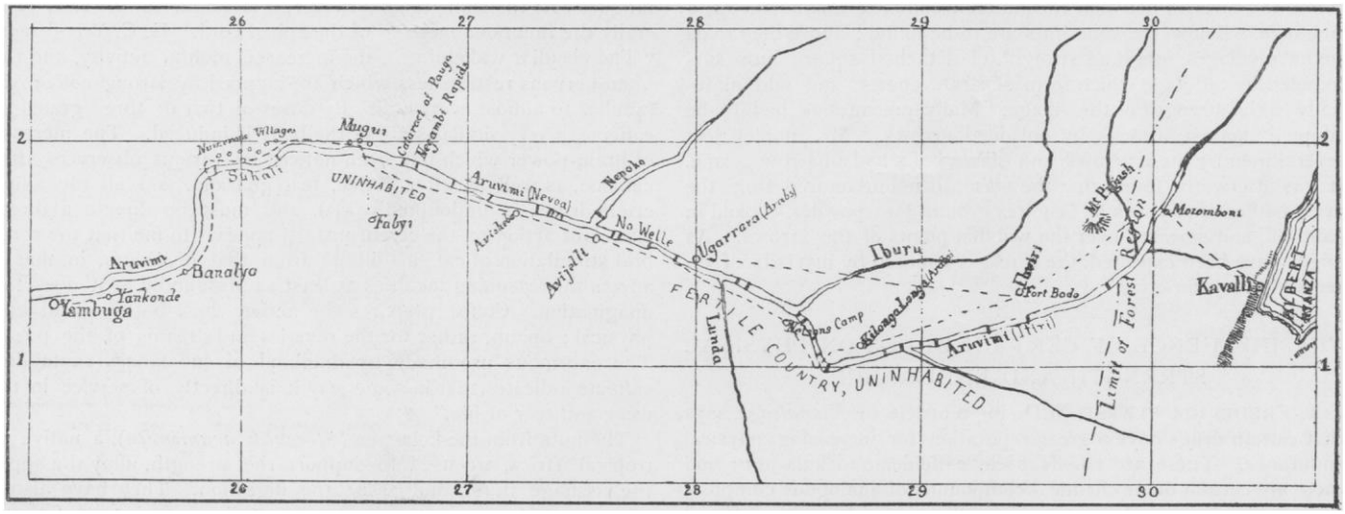
As to the river itself, the Aruvimi is, with its windings, about 800 miles long from its mouth in the Kongo to its source almost on the edge of Albert Nyanza, though the course in a direct line is probably not more than 400 miles. The banks of the river, covered with forest from the Kongo to the Nepoko, are uniformly low, here and there rising to about 40 feet. Above the Nepoko, hills begin to crop up more frequently, palms are more numerous, and the woods show the tall white-stemmed trees so characteristic of the slopes of the lower Kongo. While there are rapids at several places above Yambuga, above the Nepoko navigation becomes much more difficult, and rapids more frequent, while two considerable falls are met with. The land rises steadily, until, about 400 miles above Yambuga, the river is contracted into a rushing stream about 100 yards wide, banked by the steep walls of cañon, the slopes and summits of which are clothed with wood. Whatever changes the face of the land may show, the forest covers peak, hill, ridge, valley, plain: everywhere it is continuous, never broken, except at such clearings as man has made. Mr. Stanley very graphically compares the country traversed by his expedition to the long glacis of a fort rising from the Kongo to a height of from 5,000 to 6,000 feet. Down the slope flows the Aruvimi, one of whose feeders runs almost within sight of Albert Nyanza, to which there is a sudden drop of 2,900 feet.

The main Ituri, at the distance of 680 miles from its mouth, is 125 yards wide, 9 feet deep, and has a current of 3 knots. It appears to run parallel with the Nyanza. Near that group of cones and hills, affectionately named Mount Schweinfurth, Mount Junker, and Mount Speke, Stanley would place its highest source.

It is a most remarkable fact that the source of the Aruvimi is in so close proximity to the Albert Nyanza. Another fact of great interest Mr. Stanley refers to, — the existence of a snowy mountain which may rival Kilima Ndjaro (19,000 feet), in the neighborhood of Mount Gambaragara, or Gordon Bennett, between Albert Nyanza and Muta Nzige. This may be Mount Gordon Bennett itself; but Mr. Stanley does not think so, and he is supported by the few data which he furnishes. It would be quite in accordance with what we find in other parts of the world that a group of high peaks should be found together.

One other point of geographical interest is Mr. Stanley's observation that the Albert Nyanza is rapidly decreasing in size. A century or perhaps more ago, the lake must have been twelve or fifteen miles longer, and considerably broader opposite Mbakovia, than it is now. With the wearing-away of the reefs obstructing the Nile below Wadelai, the lake has rapidly receded, and is still doing so, to the astonishment of Emin Pacha, who first saw Lake Albert seven or eight years ago. It is to be hoped that Mr. Stanley will find time further to investigate this subject, as well as to explore the country between the Albert Nyanza and Muta Nzige, settle the position and outline of the latter, and ascertain precisely to what river system it belongs.

The abruptness with which the forest comes to an end and the



MAP SHOWING STANLEY'S GEOGRAPHICAL DISCOVERIES IN CENTRAL AFRICA.

rich grass-lands begin, about eighty miles from Albert Nyanza, is another point deserving special attention, and can only be explained when we have accurate observations of the rainfall and other conditions that go to form climate.

The character of the forest is entirely different from the open woods, with scanty underwood, of the more southerly parts of Africa. According to Stanley's description, they resemble in character the South American forests. Stanley says: "Take a thick, Scottish copse, dripping with rain; imagine this copse to be a mere undergrowth, nourished under the impenetrable shade of ancient trees ranging from 100 to 180 feet high; briers and thorns abundant; lazy creeks meandering through the depths of the jungle, and sometimes a deep affluent of a great river. Imagine this forest and jungle in all stages of decay and growth, — old trees falling, leaning perilously over, fallen prostrate; ants and insects of all kinds, sizes, and colors murmuring around, monkeys and chimpanzees above, queer noises of birds and animals, crashes in the jungle as troops of elephants rush away; dwarfs with poisoned arrows securely hidden behind some buttress or in some dark recess; strong brown-bodied aborigines with terribly sharp spears, standing poised, still as dead stumps; rain pattering down on you every other day in the year; an impure atmosphere, with its dread consequences, fever and dysentery; gloom throughout the day, and darkness almost palpable throughout the night: and then, if you will imagine such a forest extending the entire distance from Plymouth to Peterhead, you will have a fair idea of some of the inconveniences en-

dured by us from June 28 to Dec. 5, 1887, and from June 1, 1888, to the present date, to continue again from the present date till about Dec. 10, 1888, when I hope then to say a last farewell to the Kongo forest."

Mr. Stanley's description of the daily course of things in the forest region is worth quoting: "The mornings generally were stern and sombre, the sky covered with lowering and heavy clouds; at other times thick mist buried every thing, clearing off about 9 A.M., sometimes not till 11 A.M. Nothing stirs then: insect-life is still asleep; the forest is still as death; the dark river, darkened by lofty walls of thick forest and vegetation, is silent as a grave; our heart-throbs seem almost clamorous, and our inmost thoughts loud. If no rain follows this darkness, the sun appears from behind the cloudy masses, the mist disappears, life wakens up before its brilliancy. Butterflies scurry through the air, a solitary ibis croaks an alarm, a diver flies across the stream, the forest is full of a strange murmur, and somewhere up river booms the alarum drum. The quick-sighted natives have seen us, voices vociferate challenges, there is a flash of spears, and hostile passions are aroused."

Stanley does not give very detailed information regarding the tribes met with, except the statement that five different languages are spoken. He says that Negambi Rapids, about two hundred and fifty miles above the junction of the Aruvimi and the Kongo marks the division between two different kinds of architecture and language. Below, the cone-huts are to be found; above the rapids we have villages, long and straight, of detached square huts surrounded by tall logs, which form separate courts, and add materially to the strength of the village. Many precautions had to be adopted against attacks by poisoned arrows. Mr. Stanley lost several men by these arrows, and Lieut. Stairs had a narrow escape. It was afterwards found that the poison is manufactured from the dried bodies of red ants or pismires ground into powder, cooked in palm-oil, and smeared over the wooden points of the arrows. As might have been expected, the forest is haunted by myriads of insects of every variety.

THE INFLUENCE OF CERTAIN DRUGS ON PHYSICAL STRENGTH AND ENDURANCE.

T. FREDERICK PEARSE, M.D., in an article in *Knowledge*, says that certain drugs have a great reputation for increasing physical endurance. These are chiefly coca, caffeine, and kola-nut; and there are certain other chemical compounds of analogous composition which are derived from muscular tissue, and have been found experimentally to have a similar effect. These are chiefly creatine and hypoxanthine. The chemical relation of all these substances is very interesting. Strange to say, some are themselves the products of muscular waste. It will be noticed, also, that creatine and hypoxanthine occur in beef-tea, which is so well known as a general restorative and as a nervous stimulant, and there is ample experimental proof that it assists muscular power. The chemical relationship of the alkaloids found in tea, coffee, kola, and coca to the products of muscle-tissue metamorphosis suggests that these products are either replaced in the muscular tissue by these drugs, or that the products act on the nervous system either as a food or as a stimulant, and are merely supplemented in their action by the drugs. It is a very interesting question whether these alkaloids act locally on the muscle substance or upon the central nervous system.

As we know that tea, coffee, cocoa, and beef-tea sustain and strengthen the nervous energies when they have been exhausted by other than prolonged muscular action, the inference is that these substances, as well as the analogous products of muscular tissue, act also directly as food or stimulant to the nervous centres. Dr. Pearse has tested and found by experiment the powers of caffeine in increasing the respirations, and in strengthening as well as increasing the rapidity of the heart's action.

The following statements have been made by different writers as to the value of these substances. Of coca, *Markham's Peruvian Bark* says it enables a greater amount of fatigue to be borne with less nourishment, and it lessens the difficulty of respiration in ascending mountain-sides. The *Practitioner* says, "The leaves are chewed to appease hunger and support strength in the absence of food, and used generally for the stimulant and narcotic effects of tobacco and alcohol;" the *Lancet*, "It is of use to steady nerves of excitable persons (to a sportsman in shooting, for example), to give endurance; it is used by travellers in Bolivia and Peru to counteract the effect of rarefied air on mountains." Lauder Brunton writes, "In small doses it is said to lessen fatigue and enable the Indians in Peru to make long marches, and a similar result has been obtained in trials upon soldiers in Germany." Experimentally, coca appears to act in small doses as a stimulant to the nervous system, affecting first of all the cerebral hemispheres, next the medulla, and lastly the spinal cord. It lessens the feeling of fatigue, but the only mental effect seems to be an exhilaration of spirits. Like caffeine, it increases the rapidity of the heart-beat, and raises the blood-pressure.

Experimentally, caffeine has been found, in small doses, to quicken the respiration and also the pulse. It seems to affect the accelerating centre directly, as its action is equally well defined after the nerves have been divided. Besides increasing the rapidity of the heart's action, it seems also to strengthen it, and it raises the blood-pressure. Caffeine also seems to lessen tissue change and waste. In addition, caffeine appears to have some power in paralyzing the conducting power of the sensory parts of the spinal cord, and it may be in this way that it relieves the sense of fatigue. At the same time, however, it is found to increase generally the functional activity of the spinal cord. H. C. Wood says, "The peculiar wakefulness, the increased mental activity, and the often nervous restlessness which are induced by strong coffee are familiar to almost every one. By doses of two or three grains of caffeine, a very similar state of the body is induced. The increase of brain-power which has been noticed by various observers after caffeine, as well as after coffee, tea, guarana, and all the allied crude drugs, is undoubtedly real, and must be due to a direct stimulant action on the cerebrum. It appears to me that the cerebral stimulation of caffeine differs from that of opium, in that it affects the reasoning faculties at least as profoundly as it does the imagination. Coffee prepares for active work both mental and physical; opium, rather for the reveries and dreams of the poets. The enormous use made by mankind of substances containing caffeine indicates that in some way it is directly of service in the wear and tear of life."

The nuts from the kola-tree (*Sterculia acuminata*), a native of tropical Africa, are used to support the strength, allay the appetite, assuage thirst, and assist the digestion. They have also a reputation for increasing the capacity to bear prolonged fatigue. The kola-nuts contain a large percentage of the same chemical principle, theine, as is contained in tea and coffee. They also contain an aromatic volatile oil, to which some of their properties must be attributed. The seeds have been employed as a remedy for drunkenness, and they are said to abate the drink-crave. By virtue of the alkaloids, caffeine and theobromine, contained in kola, it must act as a cardiac tonic, improving both the force and rhythm of the heart. The kola-nut is slightly bitter and astringent, and its reputed value in digestive disturbances and diarrhœa may be based on these properties.

Of all inorganic compounds, the phosphates seem perhaps of the greatest importance in animal tissues. They are found in considerable quantity in the human body wherever active cell-growth is going on. They must be ranked among the most valuable and necessary foods. Their acknowledged value in disorders of the nutritive system of children, and also in convalescence from acute as well as wasting diseases, in all of which rapid growth and tissue development is taking place, is good ground for the practical inference that they are intimately concerned in nutrition generally, and especially in the recuperation of parts worn out by disease. The recovery from prolonged and severe exertion also may very probably be assisted by them. The compounds of the meta-, pyro-, and hypo-phosphates, in which the element phosphorus is loosely combined, seem much more efficacious than the ordinary salt. According to Ashburton Thompson, repeated doses of phosphates improve the appetite, increase the rate of the circulation, sharpen the mental faculties, increase the muscular power, and give a sensation of well-being.

Creatine and hypoxanthine are said, in small doses, to have the power of increasing muscular work, and to cause the muscle to recover rapidly after exertion. Creatine particularly is said to have this power to a great extent. Glycogen is also classed with these substances, and is said to have great power of increasing muscular capability.

In practice, however, we all recognize a difference in the action of the popular mixtures, — tea, coffee, cocoa, etc. In many persons tea will stimulate, and in a few it exercises a marked action on the kidneys and bladder. Coffee, again, will keep some people awake, while tea does not have the same effect with them. With some individuals it acts as a mild aperient. Coca does not seem to have any decided action on the digestive organs or kidneys.

We find, therefore, that the reputation for sustaining the strength, appeasing hunger, and temporarily increasing the physical powers, which coca, kola, coffee, and tea have in the respective parts of the world in which they are indigenous, is borne out by experiment. Moreover, there seems a probability that physiological science will shortly be able to provide a satisfactory explanation of the practical value of these substances.

BOOK-REVIEWS.

Francis Bacon, his Life and Philosophy. By JOHN NICHOL. Part II. Bacon's Philosophy. Edinburgh, Blackwood. 16°. (Philadelphia, Lippincott, $1.25.)

THIS is the latest issue in Messrs. Blackwood's series of Philosophical Classics. In the first part of the work, Professor Nichol gave an account of the life of Bacon, and in this he gives an exposition of his philosophy. He first recounts the efforts of previous thinkers, ancient and modern, to solve the physical problems of the universe, and shows how most of them failed, owing to neglect of observation and experiment, which we now know to be the most essential means of discovering physical truth. He points out, however, that before the appearance of Bacon's works the right method had come into use, and Copernicus, Kepler, Galileo, and others had made important discoveries by the use of it. Hence Bacon cannot be credited with discovering the new method, but only with being the first to generalize it and give a philosophical theory of it. He shows, as others have done, that Bacon recognized more or less clearly the various experimental methods now acknowledged by logicians, while at the same time he pointed out the defects in the induction of the ancients. Bacon also made a survey and classification of the sciences, which has not even yet lost all its interest, and which at the time it was written was quite remarkable. Bacon must also be credited, notwithstanding the defects in his moral character, with an earnest desire to serve his fellow-men, "believing," as he says of himself, "that I was born for the service of mankind." Such being his merits and such his purposes, it is important to inquire why it was that his own attempts to discover the secrets of nature resulted in nothing but failure. Professor Nichol discusses this question at considerable length, and expresses the opinion that Bacon failed partly because he had too ovenweening a sense of the power of his method, and partly because he thought the universe a far simpler thing than it really is; and he quotes Bacon's own remark, that he "should presently disclose and bring into sight all that is most hidden and secret in the world," as showing what extravagant expectations he had. But the main reason for Bacon's failure was that in his own researches he was seeking for something that does not exist. His object was to find the "forms" of things, and there has been some difficulty in ascertaining what he meant by this term. He certainly did not mean causes, and the true view is doubtless that expressed by Mill in his "Logic," and adopted by Professor Nichol. The "forms" were something "related to permanent qualities as efficient causes are to changes or events." Or, as Mill says, Bacon "seems to have thought, that, as every event has an invariable antecedent, so every property of an object has an invariable co-existent, which he called its form." But, as both Mill and Professor Nichol remark, there is no such invariable co-existent of each property of a thing; and hence Bacon, in his search after "forms," was pursuing *ignes fatui* with the usual result of landing in a bog. The failure of his own researches, however, should not blind us to his real contributions to the theory of method; and what these contributions were Professor Nichol has pointed out in the pages of this interesting work.

Curve Pictures of London for the Social Reformer. By ALEX. B MACDOWALL, M.A. London, Sampson Low. 16°.

THIS little book is intended by its author to represent, in a pictorial form, such statistics and other information as are necessary for the social reformer in his efforts to deal with the great problems which he has undertaken to help to solve. Like the leader of an army setting out on a campaign, those who are bent on doing something to right the wrongness of our social state (especially through legislation) should see clearly what *is*, while cherishing an ideal to be realized. To furnish such a guide has been the author's endeavor. Diagrams are given by which one can ascertain for a series of years the following: population; density of population; birth, marriage, and death rates; early marriages; death by disease; suicides; drunkenness; felonies; licensed houses; apprehension; pauperism; education; illiteracy; prices of commodities and prices of meat.

Marriage and Divorce in the United States. By D. CONVERS. Philadelphia, Lippincott. 16°. $1.25.

THE author of this work is a clergyman, and writes from a high-church point of view. He starts out with the remark that "marriage and divorce in the United States are in an unsatisfactory condition," and then goes on to criticise our marriage laws in detail. He calls attention to the looseness of these laws in some of the States, and to the difficulties often arising from the difference in legal requirements in different States. He strongly condemns the common-law doctrine of marriage, according to which all that is necessary to constitute a valid marriage is a mutual declaration by the two contracting parties that they take each other as husband and wife, followed by cohabitation; although he is obliged to admit that this is and always has been the canon law of the Christian church. He condemns marriage with a deceased wife's sister, which he declares to be incest. On the subject of divorce he takes the extreme scriptural ground, holding to the principle "once married, married till death." He would allow separation in case of fornication, but without liberty to marry again; while absolute divorce, such as the law now grants, he considers an abomination. He gives some tables and charts showing the rates of marriage and divorce in the different States of the Union, which will be useful to students of the subject, and also many interesting examples to illustrate the defects and inconsistencies in our marriage laws. The fault of his work is, of course, the extreme view he takes of the indissolubility of the marriage tie, — a view which the mass of men will not accept, and which it is impossible to embody in legislation. Our marriage and divorce laws need reforming, but the work must be done in a sensible and practical way, and not in a spirit of hide-bound conservatism.

AMONG THE PUBLISHERS.

IN the *Fortnightly Review* for April (New York, Leonard Scott Publication Company, 29 Park Row), Sir Charles Dilke presents the second of his series on the frontiers of India. These papers, while partly military, are largely made up of descriptions of places seldom visited by Europeans. H. H. Johnston discusses the question "Are our Foreign Missions a Success?" from the point of view of the political economist, and finds their indirect influence in matters of education and enlightenment of positive value. W. M. Gattic tells of some scandals of the English lighthouse boards, Professor J. R. Seeley's address on ethics and religion before the Ethical Society of Cambridge is printed in full. Arsene Houssaye, probably the only living survivor of the poet's friends, contributes the first section of a delightfully gossipy paper on Alfred de Musset, Mr. W. H. Mallock joins the agnostic controversy with a paper entitled "Cowardly Agnosticism," in which he points out a number of startling facts. Two papers from opposite standpoints treat of the enfranchisement of women, by Miss Fawcett and Stuart Glennie, which are especially timely in view of the fact that two bills are now before Parliament giving the suffrage to women.

Professor Dowden writes a scholarly and instructive paper on Edmond Scherer, the French poet and critic, who died in March.

— We regret to note that failing mental faculties have at last compelled Mr. George Bancroft, the historian, to abandon his literary labors.

— It is almost a year since *Scribner's Magazine* began the publication of its Railway Series; and the publishers now announce that in the June number they will begin a series of popular articles on the practical applications of electricity. Among the writers who have been already secured are Professor Cyrus F. Brackett of Princeton College, who will write a general introduction to the series; Charles L. Buckingham, chief electrical engineer of the Western Union Telegraph Company; President Henry Morton of Stevens Institute of Technology; A. E. Kennelly, chief electrical expert of Mr. Edison's laboratory; Dr. M. Allen Starr, a medical investigator of high position; Lieut. W. S. Hughes of the United States Navy; and Lieut. John Millis of the United States Army. Among the subjects of the articles will be "The Application of Electricity to Modern Telegraphy, to Lighting, to the Household, to the Human Body, to Warfare on Land and Sea, and to Large Industries." The whole series will be illustrated.

Publications received at Editor's Office,

April 8-13.

ALDEN'S Manifold Cyclopedia of Knowledge and Language. Vol. XII. Dominis to Electric Clock. New York, J. B. Alden. 12°. 50 cents.

AMERICAN Workman, The. Vol. I. No. 1. New York, O. M. Dunham. 16 p. 4°. $2.50 per year.

ANDREWS, Thomas, the Scientific Papers of the Late; with a Memoir by P. G. Tait and A. Crum Brown. London and New York, Macmillan. 514 p. 8°. $5.

BENNETT, A. W., and MURRAY, G. A Handbook of Cryptogamic Botany. London and New York, Longmans, Green, & Co. 473 p. 12°. $5.

CHORAL Book, The, for Home, School, and Church. Tr. by Friedrich Zuchtmann and Edwin L. Kirtland. Boston, Ginn. 95 p. 8°. 70 cents.

DEIGHTON, K. Shakespeare's The Winter's Tale. London and New York, Macmillan. 198 p. 60 cents.

DUPUIS, N. F. Elementary Synthetic Geometry of the Point, Line, and Circle in the Plane. London and New York, Macmillan. 294 p. 16°. $1.10.

GRAVER and Palette. Vol. I. No. 1. *q.* New York, Graver & Palette Publ. Co. 8 p. f°. 50 cents per year.

HAMILTON, D. J. A Text-Book of Pathology, Systematic and Practical. London and New York, Macmillan. 736 p. 8°. $6.25.

HOME Gymnastics for the Well and the Sick. Ed. by E. Angerstein, M.D., and G. Eckler. Tr. from 8th German ed. Boston and New York, Houghton, Mifflin, & Co. 94 p. 8°. $1.50.

HOMER'S Odyssey. Books I.-IV. Ed. by B. Perrin. Boston, Ginn. 229 p. 12°. $1.50.

JERRAM, C. S. Græce Reddenda. Oxford, Clarendon Pr. 100 p. 16°. (New York, Macmillan, 60 cents.)

LEFFMANN, H., and BEAM, W. Examination of Water for Sanitary and Technical Purposes. Philadelphia, Blakiston. 106 p. $1.25.

LONGMANS' New Atlas, Political and Physical. Ed. by Geo. G. Chisholm. London and New York, Longmans, Green, & Co. 4°. $4.

MAC DOWALL, A. B. Curve Pictures of London for the Social Reformer. London, Sampson Low. 49 p. 16°.

MACKNIGHT, J. A. Hagar. New York, Chicago, and San Francisco, Belford, Clarke, & Co. 321 p. 16°.

OIL and Gas, the Journal of. Vol. I. No. 1. *w.* Fremont, O., H. E. Woods. 8 p. f°. $2 per year.

PROCTOR, R. A. The Student's Atlas. In Twelve Circular Maps. London and New York, Longmans, Green, & Co. 23 p. 8°. $1.50.

RAIN-Fall, Report of, in Washington Territory, Oregon, California, etc., for from Two to Forty Years. Washington, Government. 101 p. 8°.

SCOTT'S Rokeby: A Poem in Six Cantos. Ed. by Michael Macmillan. London and New York, Macmillan. 280 p. 16°. 90 cents.

SMITH, R. H. Graphics; or, The Art of Calculation by drawing Lines, applied especially to Mechanical Engineering. With an Atlas of Diagrams. Part I. London and New York, Longmans, Green, & Co. 8°. $5.

STEELE, J. D. Hygienic Physiology with Special Reference to the Use of Alcoholic Drinks and Narcotics. New York and Chicago, A. S. Barnes & Co. 401 p. 12°. $1.

— D. C. Heath & Co. of Boston have in preparation an "Industrial and Educational System of Drawing," by Langdon S. Thompson, A.M., recently professor of the subject in Purdue University, and now supervisor of drawing in the schools of Jersey City.

— "Washington's Letter to Benjamin Harrison," governor of Virginia in 1784, on the Potomac navigation scheme and the general question of the opening of the West, has just been added by the directors of the Old South studies in history to their new general series of Old South Leaflets. They have also added Washington's circular letter to the governors of the States, on disbanding the army in 1783, — a letter which Washington himself felt to be so important that he termed it his "legacy" to the American people, and which discusses the political problems of the time so seriously and thoroughly that it should be read everywhere to-day along with the farewell address. The "Farewell Address" (No. 4), and the "First Inaugural," April 30, 1789 (No. 10), have already appeared in this series.

— In the *Atlantic Monthly* for May is a paper on "Temperance Legislation, its Uses and Limits," written by Charles Worcester Clark. Mr. Fiske contributes one of his historical papers on "Brandywine, Germantown, and Saratoga." Mr. W. H. Bishop writes a graphic sketch of "The Paris Exposition in Dishabille," giving its appearance when the buildings were just being completed. He also describes the Eiffel Tower, the great landmark of the exhibition. An amusing article on "The Philosophy and Poetry of Tears" is contributed by J. T. L. Preston; Mr. Frank Gaylord Cook writes about "The Lawyer in National Politics;" and reminiscences of famous "Trotting Horses" are given by H. C. Merwin. Josiah Royce contributes the first of two papers on "Reflections after a Wandering Life in Australasia;" another paper of a lighter kind, also having to do with travel, is "At Sesenheim," by Bliss Perry. Sesenheim is the place, not far from Strasburg, where Goethe wooed, won, and ran away from Freiderike.

— G. P. Putnam's Sons add to their announcements "The Ideals of the Republic, or, Great Words from Great Americans," comprising the Declaration of Independence, the Constitution of the United States, Washington's First Inaugural, Washington's Second Inaugural, Washington's Farewell Address, Lincoln's First Inaugural, Lincoln's Second Inaugural, Lincoln's Gettysburg Address. The volume will contain etched portraits of Washington and Lincoln, and will be issued as No. 20 of the Knickerbocker Nuggets. They will also publish a translation of Dante's "Convito," by Katharine Hillard; a third volume in Mr. Phyfe's series of works on pronunciation, entitled "Seven Thousand Words often Mispronounced;" and "An Essay on Money," by James Platt, author of "Business," reprinted, under arrangemeut with the author, from the nineteenth English edition. For the American Historical Association they will issue a "Report of the Proceedings at the Fifth Annual Meeting held in Washington in December, 1888." For the American Society of Church History they will publish Vol. I. of its papers, comprising "The Progress of Religious Freedom as Illustrated in the Toleration Edicts," by Philip Schaff, D.D., president of the society; "Indulgences in Spain," by Henry C. Lea, LL.D.; "The Crisis in the Middle Ages," by James Clement Moffat, D.D.; "Melanchthon's Synergism, a Study in the History of Psychological Dogmatism," by Frank Hugh Foster; "The Influence of the Golden Legend," by Professor E. C. Richardson; and "Notes on Syncretism," by Professor Hugh McDonald Scott.

— Ward, Lock, & Co. have just ready "The Life and Opinions of John Bright," by Francis Watt, fully illustrated. They will publish at once "Camps and Quarters," a series of military sketches and stories by the well-known war correspondents, Archibald Forbes, George Henty, and Charles Williams.

— Houghton, Mifflin, & Co. will shortly publish "The War for Independence," by John Fiske, which will form the first volume of a new series to be entitled The Riverside Library for Young People. This series is intended for boys and girls who are laying the foundation of libraries of their own, and will contain history, mechanics, travel, adventure, natural history, and the best class of fiction. Other volumes announced for this series are "Birds through an Opera-Glass," by Florence A. Merriam; a biography of George Washington, by Horace E. Scudder; and "Up and Down the Brooks," by Mary E. Bamford.

— Harper & Brothers have just issued another volume in the series of English Classics for School Reading, "Fairy Tales in Prose and Verse," selected from early and recent literature, and edited, with notes, by William J. Rolfe. The book is fully illustrated.

— D. Appleton & Co. have ready a revised edition of their "Dictionary of New York." It will be found a comprehensive guide not only to the historic and curious sights, but to the practical as well, such as hotels, the streets, the best modes of travel, restaurants, places of amusement, etc.

— Hubbard Brothers, Philadelphia, have in press an illustrated volume to be entitled "Living Leaders of the World." It will contain short biographies of men and women now most prominent all over the world. The portraits, mostly from new photographs, to accompany these biographies, will be in steel plate, photogravure, and woodcut. Many well-known authors are engaged upon the biographies.

— Theodore Voorhees, assistant general superintendent of the New York Central, will contribute to the May *Scribner's* one of the articles in the Railway Series, explaining the complicated machinery which is necessary to carry on the enormous freight-car service of the country. The fishing article, on "The Land of the Winanishe," will be illustrated from sketches and drawings by Dr. Leroy M. Yale, and L. R. O'Brien, president of the Canadian Academy. The advances in photography which have been made possible by the dry-plate process will be treated by Professor John Trowbridge of Harvard, who will illustrate some unique results by photographs taken under most peculiar conditions, as under water, by lamp and candle lights, and by lightning-flashes.

— D. C. Heath & Co. of Boston have ready for immediate publication, in their series of Science Guides, "Thirty-Six Observation Lessons on Common Minerals," by Henry Lincoln Clapp, master of the George Putnam Grammar School, Boston. It is not an epitome of any work on mineralogy, nor simply a collection of suggestions, but a specific, practical guide for the use of the teacher. By following its plan, the teacher becomes simply a director of the pupils' energies, thus cultivating the scientific habit of thinking and working.

— The Hon. Mrs. Maxwell-Scott of Abbotsford is preparing for publication some hitherto unpublished journals of her great-grandfather, Sir Walter Scott.

LETTERS TO THE EDITOR.

***Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

The editor will be glad to publish any queries consonant with the character of the journal.

Twenty copies of the number containing his communication will be furnished free to any correspondent on request.

New Sources of Heat.

UNDER the above heading, Mr. Lorin Blodget of Philadelphia writes to *Bradstreet's*, making several assertions as to the possibility of obtaining heat from air without the use of much carbonaceous fuel, so that it seems worth while to have the known facts in the case ventilated in the columns of *Science*. Will not some of your correspondents show us in how far Mr. Blodget may be right?

Quoting from Mr. Blodget, "in the course of the many improvements and adaptations found necessary to attain the best calorific results, and especially in the use of solid fuels for metallurgic purposes, it is certain that there is a great accession of heat from other sources than the ordinary yield from coal burned. In all cases where a powerful blast is applied to the limited area of a melting furnace, and particularly in the Bessemer converter, the degree of heat generated is greatly in excess of the theoretical yield of the number of pounds of coal consumed.

"The power of any incandescent surface to intensify the heat evolved by simply intensifying the blast is well known in many processes, but such surfaces have not been supposed to constitute a

source of heat distinct from that derived from carbonaceous combustion. It is known that the result is cumulative, but it has not been known that there was another source, in the heat evolved from the air itself. Incandescence of the non-combustible concretion, or crystallization forming the Welsbach hood or burner, is known to be a prolific source of heat as well as of light. And there are many evidences that incombustible materials of like refractory character may and do yield heat largely when incandescent under an air-blast; the presence of carbon, and the normal consumption of carbon and oxygen, not being essential or even attendant conditions.

"As a result of experiments for some years conducted, leading in this direction, and in the earlier part of this period confined to the use of an air-blast with a very small adjunct of hydro-carbon gas, the most intense metallurgic heat was produced without the use of any solid or liquid fuel, and without the production of gases as the products of combustion, in any form of carbonic acid or carbonic oxide. The very small proportions of carbonaceous gas — hydro-carbon gas — used as the means of setting the air-blast on fire not being sufficient to cause delivery of carbonic acid or oxide from the flue, no flue was used, in fact, as an upward delivery, and none was necessary.

"These trials were but steps, however, leading to a more complete substitution of atmospheric combustion by contact with incandescent surfaces, carbonaceous at first, and of anthracite or bituminous coal, the carbon of which would remain intact after hours of evolution of intense heat. The conditions of such contact are still obscure as to the point of original action or the cause of such action; but it is demonstrated that the utmost intensity of heat, not less than 4,000°, can be and is attained with a mere initiative of carbonaceous combustion, and, when once established, may be maintained for an indefinite period by merely preserving the incandescence of the surface. And this may be done by a slight manipulation of the surface brought to incandescence, and with some slight renewal of carbonaceous material.

"The direction of these results is so clear that it is assumed to be a new and practicable method of the evolution of heat for economic purposes. The air itself, which is the only body consumed, becomes a new source of heat, acting independently of the supposed limit of oxygenization or of carbonaceous combustion. Nor is any gaseous or aeriferous compound delivered as the product of such evolution of heat or combustion, if so called. We have applied the term 'combustion' heretofore to all combinations resulting in the evolution of heat enough to burn or disorganize organic matter.

"If the air itself, its nitrogen as well as its oxygen, can be made available as a direct source of heat without the attendant conditions of the formation of waste products, such as carbonic acid or carbonic oxide, the discovery is one of the greatest in human experience. It implies the substitution of an inexpensive natural fuel for the expensive natural and artificials now in use. The mere suggestion appears too great to be credible; but it is absolutely true that this is done experimentally with complete success, and that appliances are already in use, heating the air in large buildings, and melting the most refractory metals in considerable quantities. The intensity of the heat is equal to that of the blow-pipe, while the extent of space to which it is applied is adequate to any requirement for steam-generation or for manipulation of iron or other metals.

"It is only intended here to cite so much of what are admitted facts in heat-production by the usual processes as will show that other and superior aids to heat-production are already reached in many cases, and that the line of reasonable progress lies in the direction of relief from dependence on the combustion of carbon, organic or inorganic, as the source of heat for economic purposes."

X.

Any one who will have the following blank filled out by a responsible Newsdealer, and mailed to us, will be allowed a three months' subscription to *Science*.

N. D. C. HODGES,
47 LAFAYETTE PLACE, NEW YORK.

..... 1889.

To the ..... *News Company.*

You may add to my regular order five copies of SCIENCE *each week (returnable).*

.....

.....

SCIENCE CLUBBING RATES.

10% DISCOUNT.

We will allow the above discount to any subscriber to *Science* or *The Swiss Cross* who will send us an order for periodicals exceeding $10, counting each at its full price.

	Year's Subscription.	With Science.	With The Swiss Cross.
American Agriculturist	$1.50	$4.30	$2.50
American Analyst	1.00	4.25	2.25
American Architect and Building News.			
Imperial edition	10.00	12.80	11.00
Gelatine "	7.00	9.80	8.00
Regular "	6.00	8.80	7.00
American Garden	1.00	4.25	2.25
American Journal of Philology	3.00	6.25	4.25
American Machinist	2.50	5.30	4.50
American Magazine	3.00	5.80	4.00
American Naturalist	4.00	7.50	5.50
Andover Review	4.00	6.80	5.00
Atlantic	4.00	6.80	5.00
Babyhood	1.50	4.30	2.50
Babyland	.50	3.75	1.75
Bradstreet's	5.00	7.80	6.00
Brain	3.50	6.30	4.50
Building (weekly)	6.00	3.80	7.00
Carpentry and Building	1.00	4.25	2.25
Century Magazine	4.00	6.80	5.00
Chautauquan, The	1.50	4.30	2.50
Christian Union, The	3.00	5.80	4.00
Christian Weekly, Illustrated	2.50	5.30	3.50
Cosmopolitan, The	2.00	4.80	3.00
Critic	3.00	5.80	4.00
Doctor	2.00	4.80	3.00
Eclectic Magazine	5.00	7.80	6.00
Edinburgh Review	4.00	6.80	5.00
Electrical World	3.00	5.80	4.00
Electrician and Electrical Engineer	3.00	5.80	4.00
Electrical Review	3.00	5.80	4.00
Engineering and Mining Journal	4.00	6.80	5.00
English Illustrated Magazine	1.75	4.55	2.75
Family Story Paper (N.Y.)	3.00	5.80	4.00
Forest and Stream	4.00	6.80	5.00
Forum, The	5.00	7.80	6.00
Godey's Lady's Book	2.00	4.80	3.00
Harper's Bazar	4.00	6.80	5.00
Harper's Magazine	4.00	6.80	5.00
Harper's Weekly	4.00	6.80	5.00
Harper's Young People	2.00	4.80	3.00
Health and Home	1.00	4.25	2.25
Herald of Health	1.00	4.25	2.25
Illustrated London News (Amer. reprint)	4.00	6.80	5.00
Independent, The	3.00	5.80	4.00
Inter Ocean, The	1.00	4.25	2.25
Iron Age (weekly)	4.50	7.30	5.50
Journal of Philology (Eng.)	2.50	5.30	3.50
Journal of Speculative Philosophy (begins with Jan. No.)	3.00	5.80	4.00
Judge	4.00	6.80	5.00
L'Art	12.00	14.80	13.00
Life	5.00	7.80	6.00
Lippincott's Magazine	3.00	5.80	4.00
Littell's Living Age	8.00	10.80	9.00
Little Men and Women	1.00	4.25	2.25
London Quarterly	4.00	6.80	5.00
Macmillan's Magazine	3.00	5.80	4.00
Magazine of American History	5.00	7.80	6.00
Medical and Surgical Journal	5.00	7.80	6.00
Mechanical Engineer	2.00	4.80	3.00
Metal Worker	1.00	4.25	2.25
Microscope, The	1.00	4.25	2.25
Nature	6.00	8.80	7.00
New Princeton Review	3.00	5.80	4.00
North American Review	5.00	7.80	6.00
Outing	3.00	5.80	4.00
Overland Monthly	4.00	6.80	5.00
Pansy	1.00	4.25	2.25
Political Science Quarterly	3.00	5.80	4.00
Popular Science Monthly	5.00	7.80	6.00
Popular Science News	1.00	4.25	2.25
Portfolio, The	7.50	10.30	8.50
Practitioner	3.50	6.30	4.50
Public Opinion	3.00	5.80	4.00
Puck	5.00	7.80	6.00
Puck (German)	5.00	7.80	6.00
Quarterly Review (London)	4.00	6.80	5.00
Queries	1.00	4.25	2.25
Rural New-Yorker	2.00	4.80	3.00
St. Nicholas	3.00	5.80	4.00
School Journal	2.50	5.30	3.50
Scientific American	3.00	5.80	4.00
Supplement	5.00	7.80	6.00
Architect and Builders' edition	2.50	5.30	3.50
Scribner's Magazine	3.00	5.80	4.00
Southern Cultivator	1.50	4.30	2.50
Springfield Republican (weekly)	1.00	4.25	2.25
Sunday School Times	2.00	4.80	3.00
Teachers' Institute	1.25	4.05	2.25
Texas Siftings	4.00	6.80	5.00
Treasure-Trove	1.00	4.25	2.25
Truth Seeker, The	3.00	5.80	4.00
Wide Awake	2.40	5.20	3.40
Young Folks' Journal	1.00	4.25	2.25